SUPREME COURT OF THE UNITED STATES

OCTOBER TERM, 1965

No. 55

UNITED STATES, PETITIONER,

vs.

BERT N. ADAMS, ET AL.

ON WRIT OF CERTIORARI TO THE UNITED STATES COURT OF CLAIMS

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No. 17—Sheet entitled "Instruction Sheet for Testing Adams Neutro Cell, U.S.A. Patent No. 2,322,210—1943", signed Bert Adams, July 13, 1943	721	452
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No. 37—Pages 202C, 203C and 204C from the Journal of the Electrochemical Society, August, 1952 containing articles entitled "Silver Chloride-Magnesium Reserve Battery" by Ivan C. Blake and "The Cuprous Chloride-Magnesium Reserve Battery" by L. E. Pucher	725	460
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No. 2—U. S. Patent No. 282,634 to P. S. Hayes, Patented August 7, 1883, "Chloride-Of-Silver Battery"	766	515

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No. 5—U. S. Patent No. 405,196 to J. A. Barrett, patented June 11, 1889, "Galvanic Battery"	781	531
No. 6—U. S. Patent No. 457,116 by J. R. Hard, Patented August 4, 1891, "Galvanic Battery"	784	534
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No. 8—U. S. Patent No. 184,932 by Charles Louis Van Tenac, Patented November 28, 1876, "Improvement in Dry Electric Piles"	795	543
No. 9—U. S. Patent No. 434,593 to William M. Fink, Patented August 19, 1890, "Galvanic Battery"	799	546
No. 10—U. S. Patent No. 512,055 by James J. Pearson, Patented January 2, 1894, "Cartridge-Shell Battery"	803	549
No. 11—Practical Primary Cells by A. Mortimer Codd, 1929, Cover sheet, Pages 1-3, 43-44, 78-81, 110, 117	806	553
No. 12—U. S. Patent No. 1,696,873 by Robert T. Wood, Patented December 25, 1928, "Magnesium Primary Cell"	818	565
No. 13—U. S. Patent No. 1,920,151 by S. Ruben, Patented July 25, 1933, "Potential Producing Cell"	821	568
No. 14—U. S. Patent No. 2,078,143 by Lucien Jules Jumau, Patented April 20, 1937, "Regenerative Electric Cell"	825	572
No. 15—Manual of Chemistry by W. Simon, 1905, Cover sheet, and page 216	827	575
No. 16—Essentials of General Chemistry by B. Smith Hopkins and John C. Bailar, Jr., 1946, Cover sheet, fly leaf, pages 371-372 and rear cover	830	580
No. 17—British Patent Specification No. 301,923 by Guido Ferrabino, "Voltaic Cell"	835	587
No. 18—Specification forming part of Letters Patent No. 552,211 by Gustav W. Thurnauer and Milton M. Kohn, dated December 31, 1895, "Depolarizer for Primary Batteries and Method of Making Same"	837	589

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No. 19—A.D. 1880, 25th October. British No. 4341—Letters Patent to Gregoire Skrivanoff, of Paris, in the Republic of France, Gentleman, for an Invention of "An Improved Electrical Apparatus for Operating Bells, Signals, and Telegraphs"	839	591
No. 20—British No. 49—Complete Specification, "Improvements in Galvanic Batteries for Producing Constant Currents", Date of Application, 1st Jan., 1891—Accepted, 21st November, 1891	844	597
No. 21—Pages 104-116 from the Journal of Chemical Society, Vol. 53 (1888) containing article entitled "VI. The Constitution of the Copper-Zinc, Copper-Tin Alloys" by A. P. Laurie	847	601
No. 22—U. S. Patent No. 269,454 to C. D. Parkhurst, Patented December 19, 1882, "Galvanic Battery"	860	615
No. 23—U. S. Patent No. 653,770 to Albrecht Heil, Patented July 17, 1900, "Galvanic Battery"	864	618
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[fol. a]

IN THE UNITED STATES COURT OF CLAIMS

Docket No. 163-60

BERT N. ADAMS, EMMA ADAMS, GEORGE HALLINGBY (INDIVIDUALLY AND AS EXECUTOR OF THE ESTATE OF OLAF HALLINGBY, DECEASED), JANE MAESEL, IRIS PETRY, LEWIS M. SCHOTT, MARY ELLEN HALLINGBY SEIMERS, AND HELEN LOUISE SUTCLIFFE (INDIVIDUALLY AND AS EXECUTRIX OF THE ESTATE OF ERNEST M. SUTCLIFFE, DECEASED), Plaintiffs,

v.

THE UNITED STATES OF AMERICA, Defendant.

PETITION—Filed May 2, 1960

To the Honorable the Chief Judge and Associate Judges of the Court of Claims of the United States:

Plaintiffs respectfully state:

1. This is a suit to recover plaintiff's reasonable and entire compensation from defendant for the unauthorized and infringing use or manufacture by or for defendant, [fol. b] and for the unauthorized and infringing use within the United States in furtherance of the purposes of the Mutual Security Acts of 1951 and 1954, of an invention for a Battery described in and covered by United States Letters Patent No. 2,322,210 owned by plaintiffs now, or in the past, and further to recover damages for defendant's breach of implied and/or express contracts existing between defendant and said plaintiffs relating to compensation of plaintiffs for use or manufacture by or for defendant of said invention or batteries disclosed to said defendant by plaintiff Bert N. Adams.

* * * * * * *

[fol. c] 4. United States Letters Patent No. 2,322,210 for "Battery", were duly issued on June 22, 1943 to plaintiff Bert N. Adams, the inventor (hereinafter sometimes referred to as "plaintiff Adams"), on an application filed December 18, 1941. All claims of the patent, numbers 1-11

inclusive, are in suit here and defendant is charged with infringing all of them.

* * * * * * *

[fol. d] 11. Upon information and belief, within six years next prior to March 7, 1957 and continuing to the date of filing this petition, batteries embodying the invention and infringing the claims of Letters Patent No. 2,322,210 were used or manufactured by or for defendant, and were used within the United States* without authorization or license of plaintiffs and without lawful right to use or manufacture the same, by:

U. S. Signal Corps Laboratories,
Fort Monmouth, N. J.
Ray-O-Vac Battery Company,
Burgess Battery Company,
National Carbon Company,
Eagle-Picher Company,

and possibly by others now unknown to plaintiffs.

12. In or about December 1941, plaintiff Adams went to the Navy Department, and disclosed to defendant full and complete information about, and consented that defendant use and manufacture his battery and invention with the understanding that he would be compensated for such use and manufacture. On information and belief plaintiff Adams met with a Captain R. S. Shumaker of the Navy, among others.

[fol. e] 13. In or about January 1942, plaintiff Adams disclosed to defendant, through its National Inventor's Council, information concerning his battery and invention, in reliance upon the contractual promise, express and/or implied, of the Council, as an agency of defendant that defendant would hold the information in confidence and/or make no use of the battery and invention without compensating plaintiff Adams therefor.

---

* "Used within the United States" includes use in furtherance of the purposes of the Mutual Security Acts of 1951 and 1954.

14. In or about January 1942, a second meeting was held at the Navy Department between plaintiff Adams and representatives of defendant. At said second meeting, plaintiff Adams was advised to take sample batteries to the Signal Corps Laboratories, Fort Monmouth, New Jersey, and plaintiff Adams was again led to believe by defendant that he would be compensated for his disclosure and for use made of his invention and battery by or for defendant.

15. On each of several dates, namely on or about February 9, 1942, March 13, 1942, January 11, 1943, January 20, 1943, July 10, 1943, August 10, 1943, June 22, 1948, and possibly others, plaintiff Adams delivered one or more batteries to the Signal Corps Laboratories of defendant at Fort Monmouth, New Jersey, in response to an official request from representatives of defendant.

16. On information and belief, plaintiff Adams conferred with one or more of the following persons on his several trips to the Signal Corps Laboratories, Fort Monmouth, New Jersey: Dr. V. F. Payne, Mr. S. R. Daniels, Mr. Ellis, Dr. Adolph Fischbach, Captain Clarence R. Kingston and various other representatives of the Government. At the conferences held with the above-named representatives, plaintiff Adams made full and complete disclosures of his invention and battery and consented that defendant use his invention and patent and battery. Plain-
[fol. f] tiff Adams was led to believe that he would be compensated for his disclosure and for use made by or for defendant of his invention, patent and battery.

* * * * * * *

20. A written claim for compensation for disclosure of information, and for use of said invention and said patent was presented to defendant through the Department of Defense on March 7, 1957. Defendant now takes the position, through its Department of Defense, that plaintiffs'
[fol. g] claims have been finally denied by defendant and therefore that plaintiffs' remaining recourse is to seek relief in the Courts.

* * * * * * *

[fol. h] Wherefcre, plaintiffs pray for judgment against defendant for such sums as may be found, after completion of proofs herein and an accounting, to be the damages for breach of contract and the reasonable and entire compensation due plaintiffs for all unauthorized or unlicensed or unlawful use or manufacture by or for defendant and use within the United States of the said patented invention and battery, including interest as part of such entire and reasonable compensation, and for such other and further relief as this Court may find to be just and proper in the premises.

/s/ John A. Reilly, Attorney for Plaintiffs, Office and Post Office Address, 165 Broadway, New York 6, N. Y.

Of Counsel: Kenyon & Kenyon, James H. Callahan, New York, N. Y.

[fol. i] [File endorsement omitted]

IN THE UNITED STATES COURT OF CLAIMS

No. 163-60

[Title omitted]

DEFENDANT'S ANSWER TO PETITION—filed November 18, 1960

Now comes the defendant, by its Assistant Attorney General, and answers the petition filed on May 2, 1960 as follows:

(1) Defendant denies each and every allegation in paragraph 1 of the petition except that defendant admits issuance of United States Letters Patent No. 2,322,210.

* * * * * * *

[fol. j] (4) As to paragraph 4, defendant admits only that United States Letters Patent No. 3,322,210 entitled [fol. k] "Battery" issued with 11 claims to Bert N. Adams on an application filed December 18, 1941. Defendant

specifically denies infringement of said Letters Patent 2,322,210.

Defendant further denies that Bert N. Adams is an "inventor", or that said patent was "duly issued" with respect to any subject matter disclosed or claimed in said patent, insofar as the legal requirements for invention defined by the patent statute or applicable decisions are concerned.

* * * * * * *

[fol. l] (11) Defendant denies each and every allegation in paragraph 11 of the petition, leaving plaintiffs to make strict proof thereof.

(12) Defendant is without knowledge or information sufficient to form a belief, and therefore denies each and [fol. m] every allegation in paragraph 12 of the petition.

(13) Defendant denies each and every allegation in paragraph 13 of the petition, except that defendant admits on information and belief that a letter relating to plaintiff Adams' alleged invention was transmitted to the National Inventors Council in January of 1942.

(14) Defendant is without knowledge or information sufficient to form a belief, and therefore denies each and every allegation in paragraph 14 of the petition.

(15) Defendant is without knowledge or information sufficient to form a belief, and therefore denies each and every allegation in paragraph 15 of the petition, except that defendant admits on information and belief the existence of a letter from Bert N. Adams dated March 25, 1942, to Fort Monmouth which mentions the submission of samples, and defendant further admits on information and belief the existence of test records maintained by personnel at Fort Monmouth which determined that units constructed in accordance with the teachings of United States Letters Patent No. 2,322,210 were inoperative and completely unsuitable for their intended purpose.

(16) Defendant is without knowledge or information sufficient to form a belief and therefore denies each and every allegation in paragraph 16 of the petition, except that defendant admits on information and belief the recollection

by a Mr. A. P. Daniels of a conversation held with Bert N. Adams sometime in 1942.

* * * * * * *

[fol. n] (20) Defendant admits, on information and belief, that a claim for compensation solely on behalf of plaintiff Bert N. Adams was made on March 7, 1957. Defendant denies that any communication from The Department of Defense comprises a final denial of "plaintiffs' " claims, in that no administrative claim on behalf of any plaintiff *other* than said Bert N. Adams was ever presented.

Further answering, defendant denies each and every other remaining allegation in paragraph 20.

* * * * * * *

[fol. o] Wherefore, defendant prays that the petition herein be dismissed with costs assessed against plaintiffs.

Respectfully submitted, /s/ George Cochran Doub, Assistant Attorney General. /s/ Paul F. Arseneau, Attorney, Department of Justice.

[fol. p] IN THE UNITED STATES COURT OF CLAIMS

No. 163-60

[Title omitted]

MEMORANDUM OF PRETRIAL CONFERENCE—June 8, 1961

The parties met, pursuant to notice, in the Commissioner's office, United States Court of Claims, Washington, D. C., June 8, 1961.

Present: Donald E. Lane, Commissioner, John A. Reilly, Esq., for plaintiffs, Paul F. Arseneau, Esq., for defendant,

Also present: Robert Randall, Esq., T. Hayward Brown, Esq., H. M. Saragovitz, Esq., and Major F. K. Richwine.

1. Counsel for the parties furnished to the Commissioner a stipulation signed by counsel June 8, 1961, and comprising five pages. This stipulation was approved by the

[fol. q] Commissioner and will be filed in the record in this case when all of the exhibits mentioned therein have been supplied by counsel.

2. Counsel for plaintiffs stated that it is the position of plaintiffs that silver chloride is an equivalent of cuprous chloride plus carbon when used in batteries having a magnesium electrode.

3. Defendant's counsel stated that defendant will immediately seek and deliver when available to plaintiffs' counsel drawings or sketches showing the types of reserve type, water-activated primary batteries containing a magnesium anode and a cathode comprising cuprous chloride; or cuprous chloride and silver chloride, procured by and delivered to the defendant within the 6-year period next preceding the filing of the petition herein. Each sketch will show the composition of the anode (if different than ordinary commercial magnesium sheet), the composition of the cathode, the composition of the separator, if any; the composition of the electrolyte, if any, and the composition of any other components or material present upon activation, that takes part, or may take part, in the action of the cell. Each sketch will be accompanied by a [fol. r] full disclosure of the manufacturing process for making the cathode shown in the sketch, including details of any use of temperatures or pressures above room temperature or atmospheric pressure, or employment of liquids, solvents, binders, plastics, thermoplastics or other additives which may or may not appear in the completed cathode, or employment of special manufacturing techniques such as rolling, hot rolling, milling, and calendering, compressing and the like. Defendant's counsel will produce and file with the Commissioner one sample of a water-activated battery having a magnesium anode and a silver chloride cathode, such as procured by the defendant during the 6-year period next preceding the filing of the petition.

4. Counsel for defendant agreed that defendant will notify plaintiffs on or before June 22, 1961, which of the now cited prior art items may be eliminated from consideration by plaintiffs, and also agreed to notify plaintiffs on or before said date the names of defendant's fact witnesses, as far as then known.

5. Plaintiffs' counsel stated that both Mr. and Mrs. Bert

[fol. s] N. Adams will be available at the trial and that plaintiffs expect to call only one expert witness, and will advise defendant of the names of the fact witnesses on or before June 22, 1961.

6. The parties stipulated that the following documents be offered and received in evidence without objection as trial exhibit 13:

(1) Information Bulletin No. 1 of the National Inventors Council dated 1941;

(2) Information Bulletin No. 2 of the National Inventors Council dated 1942, and that such exhibit comprises accurate copies of genuine originals and may be used at the trial with the full force and effect of certified copies, and that such bulletins were available to plaintiff Bert N. Adams as of the dates thereof, and as to Information Bulletin No. 2, that it was received by said Adams on or about February 7, 1942, as an enclosure to a letter dated February 7, 1942, from Green to Sandhaas previously produced by defendant.

7. Commissioner, in response to defendant's request, extended defendant's time to oppose plaintiffs' motion under Rule 26, filed June 2, 1961, to expire on June 16, 1961.

[fol. t] 8. The Commissioner directed that defendant respond to plaintiffs' request for admissions, filed with the Commissioner June 5, 1961, on or before June 22, 1961.

9. Military specification MIL-B-17482B (SHIPS) dated 10 December 1958, comprising 15 printed pages, was marked Commissioner's exhibit 1 herein, was received in evidence without objection, and is filed herewith. Defendant agreed to determine whether or not defendant has procured batteries made in accordance with said specification during the 6-year period next preceding the filing of the petition.

10. A photostatic copy of the proceedings of the Tenth, Eleventh and Twelfth Annual Battery Research and Development Conferences, comprising 18 pages, was marked Commissioner's exhibit 2, was received in evidence without objection, and is filed herewith.

/s/ Donald E. Lane, Commissioner

[fol. u] [File endorsement omitted.]

[fol. v] [File endorsement omitted]

IN THE UNITED STATES COURT OF CLAIMS

No. 163-60

[Title omitted]

STIPULATION TO BE SUBMITTED TO THE HONORABLE COMMISSIONER DONALD E. LANE AT THE PRE-TRIAL HEARING—Dated June 8, 1961 and Filed June 14, 1961.

Jurisdiction

1. The parties stipulated that this Court has jurisdiction over all the parties hereto, and over the issues raised by the petition and answer heretofore filed herein.

Separation of Issues

2. The parties agreed that upon proof of the manufacture by or for, or the use by or for, the United States, of one or more articles alleged in the petition, or otherwise alleged on the record, to infringe the patent in suit, the issues of validity and infringement of the patent by the United States, will be first determined upon full proofs, findings of fact, and argument of counsel. The parties further agreed that the accounting issue including evidence as to the number of articles procured and/or the value of the patented inventions, or the extent of the liability, if any, of the United States, and the amount of [fol. w] reasonable and entire compensation, if any, due to plaintiffs on account thereof, will be deferred until after the entry of the order of the Court of Claims on the issues of validity and/or infringement.

Admissions

3. Defendant admitted that articles made as described in the documents offered and received in evidence without objection as Trial Exhibit 1, filed herewith, were procured by and delivered to the defendant within the six-year period next preceding the filing of the petition.

4. Soft copies of U.S. Letters Patent Nos. 2,636,060 to

Fischbach et al., 2,640,090 to Pucher et al., 2,640,091 to Pucher et al., 2,667,527 to Pucher and Reissue 23,883 to Chubb were respectively offered and received in evidence without objection as Trial Exhibits 2, 3, 4, 5 and 6, and are filed herewith.

5. Defendant admitted that the articles identified as Trial Exhibits 7, 8 and 9 offered and received in evidence without objection and filed herewith were procured by and delivered to the defendant within the six-year period next preceding the filing of the petition.

6. Defendant admitted that U.S. Letters Patent No. 2,322,210 was granted by the Commissioner of Patents to Bert N. Adams on June 22, 1943.

Stipulated Testimony

7. The parties stipulated that the record evidences delivery by Bert N. Adams of battery cells made by him to the [fol. x] U. S. Signal Corps Laboratory at Fort Monmouth, N. J., as follows:

Date	No. of Cells Delivered
January 26, 1942	1 cell
February 9, 1942	2 cells
March 26, 1942	10 cells
June 22, 1948	1 cell

Waiver of Certification

8. The parties agreed that uncertified copies of United States and foreign letters patent and publications may be offered in evidence by either party with full force and effect of certified copies, and that said uncertified copies may be considered as having been filed, granted or published on the dates and at the places appearing upon them, and the names of the author and publisher appearing on such publications shall be accepted as correct, subject to correction by the production of originals or certified copies. The parties further agreed that uncertified copies of drawings, correspondence, and other documentary evidence, agreed to by counsel, may be offered in evidence by either party with the full force and effect of certified copies, subject to correction if error be shown to appear.

Dates of Invention Asserted by Plaintiffs

9. Defendant has requested that plaintiffs make of [fol. y] record for the purposes of this case the dates of invention upon which plaintiffs will rely. Plaintiffs state that they will rely on a date no earlier than September, 1939 for conception and on a date no earlier than March, 1940 for reduction to practice of the invention claimed in the patent in suit.

Exhibits Received

10. A soft copy of U. S. Letters Patent No. 2,322,210 was offered and received in evidence without objection as Trial Exhibit 10, and is filed herewith.

11. A certified copy of the file wrapper of U. S. Patent No. 2,322,210 was offered and received in evidence without objection as Trial Exhibit 11, and is filed herewith.

12. The parties stipulated that each of the documents offered and received in evidence without objection as Trial Exhibit 12, filed herewith, which are the documents served on behalf of defendant on plaintiffs on May 19, 1961 pursuant to the Stipulation filed herein on February 17, 1961 is an accurate copy of a genuine original and if the document is a letter, it is further stipulated that such was written by or for the person, department or organization whose name or identification appears thereon as the author thereof, and was sent to and received by the person, department, or organization indicated thereon as the addressee thereof, on or about the date appearing on the [fol. z] document; and that the "William Shorr" whose name appears in certain of these documents was employed by the defendant at Ft. Monmouth, New Jersey, on the dates indicated on the documents on which his signature appears.

/s/ John A. Reilly, Attorney for Plaintiffs, 165 Broadway, New York 6, New York.

Dated: June 8, 1961

/s/ William H. Orrick, Jr., Assistant Attorney General.

Dated June 8, 1961

/s/ Paul F. Arseneau, Attorney, Dept. of Justice.

Dated June 8, 1961

[fol. aa] IN THE UNITED STATES COURT OF CLAIMS

No. 163-60

BERT N. ADAMS, et al

vs.

THE UNITED STATES

Washington, D. C.,
Monday, July 10, 1961,
thru Friday, July 14, 1961.

MASTER INDEX

Witnesses:	Direct	Cross	Redirect	Recross
Bert N. Adams	31	121	137	...
Emma Adams	138	...	...	...
Charles L. Mantell	145	402	457	...
Howard Raymond Knapp	461	507	...	...
Joseph C. White	572	636	642	...
Charles L. Mantell (Recalled)	645	647	...	...

EXHIBITS

Trial		For Id	In Evi
14	Stipulation of July 6, 1961 with enclosures together with Patent Office certification and instruments of writing as received May 26, 1961	3	3
18	Burgess battery	4	...
19	Letter accompanying Burgess battery dated July 7, 1961	4	...
20	Letter dated June 22, 1961 from Department of Justice to Commissioner Lane	...	11
Commissioner's:			
3	Certified copy from the General Accounting Office of Contract NOBs 20600 between USA and Thomas A. Edison, Inc., Primary Battery Division	...	120

EXHIBITS

Commissioner's:

[fol. bb]

Trial		For Id	In Evi
4	Folder entitled "Defendant's Answer and Response to Paragraphs 12 and 15 of the Stipulation Filed on February 17, 1961"	...	120

Plaintiff's:

1	Two sheets of invoice headed "Date Shipped 2–2–40 From Midland, Michigan, in re Dow Metal M Sheets CP .040" and .020","	38	39
2	Two page document the first of which shows a curve and the second of which states "Summary of Test of Original Cell August 29, 1940"	45	183
3	One-page document headed "N. Y. March 13-14, 1941 Capacity Test of Neutro Cell"	...	48
4	Physical exhibit, being glass jar, dated November 21, 1941, with magnesium anode and cathode of cuprous chloride, blended with carbon	...	52
5	Physical exhibit, being a tubular object about four inches long	53	...
6	Physical exhibit, being a cylindrical object with two wires attached	53	56
7	Physical exhibit, being made of glass with a label on it dated 1943	53	56
8	Physical exhibit, being a rectangular object	54	56
9	Physical exhibit, being plastic cylinder	55	56

EXHIBITS

Plaintiff's:

Trial		For Id	In Evi
10	Five page document consisting of a letter of March 4, 1941 from Bert Adams to National Battery Company together with four other sheets consisting respectively of sheets entitled "Neutro Cell Characteristics," "Graph,"		
[fol. cc]			
	"The Possibilities of the Neutro Cell" and notes appearing in handwriting on back of page 4	57	59
11	Five-page document, the first page of which is entitled "Possibilities of the Neutro Cell." the second and third pages entitled "Neutro Cell Characteristics," fourth page entitled "Formula for Computing Capacity by Weight and Surface Exposed," and the fifth sheet showing "Capacity—Linear Potential—Small Weight,"	60	62
12	Document consisting of four pages the first page of which is a letter dated April 3, 1941 to Thomas A. Edison, Inc., together with letter dated April 17, 1941 from Thomas A. Edison, to Bert Adams, plus two graphs	63	64
13	Telephone Message from Dodge Hotel dated January 22, 1942	...	71
14	Document entitled "Adams Neutro Cell," consisting of one page, and signed by Bert Adams, heretofore marked for identification	...	93
15	One-page document showing graph and showing test of high-temperature cell for U. S. Signal Corps, dated May 16, 1943	...	94

EXHIBITS

Plaintiff's:

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16	Pages 701 through 704 inclusive from the August 1950 issue of Electrical Engineering, containing article entitled "Special Purpose Batteries," by Adolph Fischbach	...	109
17	Sheet entitled Instruction Sheet for Testing Adams Neutro Cell, dated July 13, 1943	...	109
18	Burgess Battery Company brochure	...	113
19	Five-page document headed "Ray-O-Vac Engineering Bulletin," on characteristics of the magnesium cuprous chloride battery	...	113
[fol. dd]			
20	Life jacket together with battery	...	163
21	Jar of cuprous chloride	...	168
22-25	Four sheets of paper to which was attached copper screens, showing respectively weight of 2.7 grams, 3.85 grams, 3.7 grams and 2.9 grams, marked respectively	233	234
26-29	Sheets headed "CuCL Pasted Type, with weight of paste 3.1 grams, 2.9 grams, 3.0 grams and 3.4 grams," respectively	...	250
30	Sheet headed "CuCL Pasted Type with screen attached, showing weight of paste 3.8 grams"	...	250
31	Sheet headed "CuCL Pasted Type, with Screen attached, showing weight of paste 3.5 grams"	...	250
32	Sheet headed "CuCL Pasted Type, with screen attached, showing weight of paste 3.4 grams"	...	251
33	Sheet headed "CuCL Pasted Type with screen attached, showing weight of paste 3.6 grams"	...	251

EXHIBITS

Plaintiff's:

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34	See Comm.		
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36-1 36-2	Chart drawn by the witness with three headings, "Adams, Fischbach, Chubb, Pucher patents and Ray-O-Vac"	...	294
37	Pages 202C 203C and 204C from the Journal of the Electrochemical Society, August 1952	...	302
38	One-page chart headed Cell No. 10	...	343
39	Photostat consisting of pages 528 through 545 from paper entitled "Characteristics of the Silver Chloride-Magnesium Water Activated Battery," by J. B. Mullen and P. L. Howard	...	380
40	Patent No. 2,817,697 to M. F. Chubb dated December 24, 1957	...	401

[fol. ee]

41	Patent No. 2,745,983, to M. F. Chubb, dated May 15, 1956	...	401
42	Pages 1, 2 and 3 together with cover page and preface page of an article entitled "Primary Batteries," by George Wood Vinal	...	427
43	Page 129 and 130 from Aviation Week for July 11, 1960, entitled "Missile Engineering"	...	642

Defendant's:

1	Elementary Treatise on Batteries, Niaudet (1880), Cover sheet, Page ix, pages 200-209	...	633
2	U.S. Patent No. 282,634 to Hayes (1883)	...	633

EXHIBITS

Defendant's:

Trial		For Id	In Evi
3	Galvanic Batteries, Bottone, (1902) Cover sheet, Pages 172–177	...	633
4	Primary Batteries, Carhart (1891) Cover sheet, pages 62–65	...	633
5	U.S. Patent No. 405,196—Barrett (1889)	...	633
6	U.S. Patent No. 457,116—Hard (1891)	...	634
7	U.S. Patent No. 454,598—Hathaway (1891)	...	634
8	U.S. Patent No. 184,932—Vantenac	...	634
9	U.S. Patent No. 434,593—Fink (1890)	191	634
10	U.S. Patent No. 512,055—Pearson (1894)	...	634
11	Practical Primary Cells, Codd (1929) Cover Sheet, Page 1–3, 43, 44, 78, 79, 80, 81, 110 and 117	...	634
12	U.S. Patent No. 1,696,873—Wood (1928)	...	634
13	U.S. Patent No. 1,920,151—Ruben (1933)	...	634
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14	U.S. Patent No. 2,078,143—Jamau (1937)	...	634
15	Manual of Chemistry, Simon (1905) Cover Sheet, Page 216	...	634
16	Essentials of General Chemistry, Hopkins & Bailar (1946) Cover Sheet, Pages 371, 372; fly leaf, rear cover	...	634
17	British Patent No. 301,923—Ferrabino (1928)	...	635
18	U.S. Patent No. 552,211—Thurnauer (1895)	...	635
19	British Patent No. 4341 (1880—Series) Skrivanoff	...	635
20	British Patent No. 49 (1891) Wensky	...	635

EXHIBITS

Defendant's:

Trial		For Id	In Evi
21	Journ. Ch. Socy., Vol. 53 (1888) pp 104–116 Constitution of Copper-Zinc,—Copper-Tin Alloys, —Laurie	...	635
22	U.S. Patent No. 269,454—Parkhurst (1882)	...	635
23	U.S. Patent No. 653,770—Heil (1900)	...	635
24	U.S. Patent No. 1,522,121—Harrison (1925)	...	635
30	Signal Corps Invention Record and Log Book	466	486
31	Burgess 259/AM battery described on page 3 of Defendant's Exhibit No. 30	469	487
31-A	Sample No. 1 described on page 3 of Defendant's Exhibit No. 30	469	487
31-B	Sample No. 2 described on page 3 of Defendant's Exhibit No. 30	469	487
31-C	Sample No. 3 described on page 3 of Defendant's Exhibit No. 30	469	487

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31-D	Sample No. 4 described on page 3 of Defendant's Exhibit No. 30	469	487
31-E	Sample No. 9 described on page 4 of Defendant's Exhibit No. 30	471	487
31-F	Sample No. 10 described on page 4 of Defendant's Exhibit No. 30	471	487
32	Eagle-Picher 259/AM battery described on page 6 of Defendant's Exhibit No. 30	...	487
32-A	Sample No. 14 described on page 6 of Defendant's Exhibit No. 30	...	487
32-B	Sample No. 15 described on page 6 of Defendant's Exhibit No. 30	...	487
32-C	Sample No. 16 described on page 6 of Defendant's Exhibit No. 30	...	488
32-D	Sample No. 17 described on page 6 of Defendant's Exhibit No. 30	...	488

EXHIBITS

Defendant's:

Trial		For Id	In Evi
33	Ray-O-Vac 292/AM Battery, described on page 6 of Defendant's Exhibit No. 30.	...	488
33-A	Sample No. 18 described on page 6 of Defendant's Exhibit No. 30.....	...	488
33-B	Sample No. 21 described on page 10 of Defendant's Exhibit No. 30.....	...	488
33-C	Sample No. 22 described on page 10 of Defendant's Exhibit No. 30.....	...	488
34	Ray-O-Vac 253/U Battery, described on page 11 of Defendant's Exhibit No. 30.	...	488
34-A	Sample No. 23, described on page 11 of Defendant's Exhibit No. 30.....	...	488
34-B	Sample No. 24 described on page 11 of Defendant's Exhibit No. 30.....	...	488
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35	Sample No. 12, described on page 1, 2 and 5 of Defendant's Exhibit No. 30...	...	488
36-A	Sample No. 19 described on page 8 of Defendant's Exhibit No. 30.....	...	489
36-B	Sample No. 20 described on page 8 of Defendant's Exhibit No. 30.....	...	489
37	Cover page and the second page and pages 219 and 220 of book by George Wood Vinal entitled "Storage Batteries" 1940 ed.....	501	563
40	Excerpts from Hackh's Chemical Distionary heretofore marked and received as Defendant's Exhibit No. 2 was remarked.....	...	573

[fol. 1]

IN THE UNITED STATES COURT OF CLAIMS

BERT N. ADAMS, et. al., Plaintiffs,

vs.

THE UNITED STATES, Defendant.

No. 163-60

Washington, D. C.,
10:00 o'clock a.m.

Transcript of Testimony for plaintiffs—July 10, 1961

The parties met, pursuant to notice of the Commissioner, at the time above stated, in Trial Court Room No. 1, United States Court of Claims.

PRESENT:

Hon. Donald E. Lane, Commissioner.

Kenyon & Kenyon, By: John A Reilly, Esq., and Richard A. Huettner, Esq., Counsel for Plaintiffs.

T. Hayward Brown, Esq., and Paul F. Arseneau, Esq., Counsel for Defendant.

Also Present:

Bernard Wohlfert, Esq.

Mr. Kenneth K. Johnston, reporter, was thereupon sworn by the Commissioner to well and truly take down and tran-
[fol. 2] scribe the questions propounded to and the answers given by the witnesses, and to do all other things required of him by the Commissioner.

Pursuant to the order of reference by the Honorable, The United States Court of Claims, in the above-entitled cause, testimony on behalf of the Plaintiffs was taken, as follows:

COLLOQUY BETWEEN COURT AND COUNSEL

Commissioner Lane: We have this morning the case of Bert N. Adams, et al., against the United States. I note a number of exhibits here. I might say that I have Commissioner's Exhibits Nos. 1 and 2 and I have Trial exhibits

which have been marked from 1 through 17, and I believe the Plaintiff has Exhibits Nos. 7, 8 and 9.

Mr. Reilly: That is correct, Your Honor.

Commissioner Lane: I suggest that you turn all of them over to the reporter.

I also have in front of me a certified copy of the Patent Office of Instruments of Writing, filed May 26, 1961, and I do not have any identification number on it. Does anyone know what number this is?

Mr. Reilly: I think Mr. Arseneau filed a stipulation covering that.

Mr. Arseneau: The stipulation refers to it as Trial Exhibit No. 14, and perhaps my letter of transmittal does also. I believe the original stipulation shows it as Trial Exhibit No. 14.

[fol. 3] Mr. Reilly: I have it here. Your Honor, the stipulation covers the exhibits, and those are the documents all the way through from the start to the very end.

Commissioner Lane: I have both the stipulation and the certified copy, and they will be marked Trial Exhibit No. 14.

(Stipulation of July 6, 1961 with enclosures together with Patent Office certification and instruments of writing as received May 26, 1961 were marked Trial Exhibit No. 14.)

Commissioner Lane: There is one other item I have before me: I have received from the Defendant a Burgess battery and a request that it be marked as a Commissioner exhibit, and I wonder if Plaintiff has seen this?

Mr. Reilly: I have not seen it, Your Honor, and I would appreciate the opportunity.

Commissioner Lane: This was on my desk this morning, and you might take it and look at it.

Mr. Reilly: May I ask, is this the battery referred to, Mr. Arseneau?

Mr. Arseneau: Yes, sir, and it was filed in accordance with the pretrial memorandum which requested the Defendant to produce a silver chloride battery.

Mr. Reilly: We might have it identified, I think, Your Honor. May we have it identified as the next trial exhibit number, which will be No. 18?

Commissioner Lane: Very well, the Burgess battery will

[fol. 4] be marked as Trial Exhibit No. 18 for identification.

(Burgess battery marked Trial Exhibit No. 18 for identification.)

Mr. Reilly: May we also identify the letter as Trial Exhibit No. 18, or maybe we better make it No. 19, and that will be the letter of July 7th which accompanied this battery.

(Letter accompanying Burgess battery dated July 7, 1961 was marked Trial Exhibit No. 19 for identification.)

Commissioner Lane: It is not necessary for the parties to make an opening statement before we start the testimony. I might state that I have read the stipulation and I have read the patent in suit. I have not read all the exhibits, however. If either of the parties desire to make an opening statement, they should feel free to do so at this time.

I understand we have in this trial the issues of infringement and validity of the Adams patent in suit.

If Plaintiffs' attorney desires to make an opening statement, I will hear it now.

Mr. Reilly: May I state for the record that there was filed Trial Exhibit No. 15. Do you have a copy of that, that being a group of documents, and also with Trial Exhibit No. 15, Trial Exhibit No. 16 was filed as part of the same stipulation?

[fol. 5] Commissioner Lane: Yes, I have Trial Exhibits Nos. 15 and 16 and the stipulation which accompanied them. They are in the folder.

Mr. Reilly: Thank you.

We also had filed Trial Exhibit No. 17, which is also a folder of documents.

Mr. Arseneau: I think what took place is this, Your Honor:

The original copies of these were filed, and the carbon in some cases was forwarded on July 7th, and I think some of the carbons might not have accompanied them.

Mr. Reilly: May I inquire what is coming in in addition? Is there something else coming in under the stipulation? I understand there was a copy of the letter sent to the Commissioner with respect to Trial Exhibit No. 18.

Mr. Arseneau: Yes, sir, there is. I intended to bring the copies, if they arrive this morning, not only the file in the matter but also to provide you with copies but they are definitely not here now but I expect them to be here within an hour or so.

Mr. Reilly: Do you mind telling me what this will be?

Mr. Arseneau: Not in the least. I would be glad to clear up the record to that extent.

First of all, we sent a statement, showing a few more patents to be relied upon with respect to the state of the [fol. 6] art.

Mr. Reilly: This is the first time they have been mentioned?

Mr. Arseneau: That is true.

Mr. Reilly: What else is coming in?

Mr. Arseneau: The last paragraph of the document referred to the fact that we would want to hand in a copy thereof on July 10th, prior to the trial session.

I assure you that all these matters will be placed in your hands before the end of this morning.

The other carbon copy which we propose to hand in is merely a copy of a certified contract, and it can be made a Commissioner's exhibit, if you wish.

Mr. Reilly: What is that?

Mr. Arseneau: I will explain it.

In the voluntary discovery stipulation filed February 16, 1961 there were certain paragraphs which obligated Defendant to inquire of the contractors to furnish copies of tests reports and the like. There are also certain test reports which have come to our attention in a looseleaf or bound book arrangement, and they will be filed with the Court and copies will be given to you.

Mr. Reilly: Actually what are they?

Mr. Arseneau: Actually they are test reports on batteries which were constructed by Thomas A. Edison in New [fol. 7] Jersey, and they have come to us recently. We have discovered that an Italian distress torch was found, and we ourselves don't have it now, and the write-up on the distress torch was from the British and it shows the dropping of it in sea water.

When the Naval Research and Development Laboratory got the letter dated December 16, 1943, it had the Edison

Company in New Jersey to make one hundred for experimental purposes. The samples of these batteries which were constructed by Thomas Edison, at least three or four of them, were sent to the Naval Research and Development Laboratory.

We expect to be able to place the material in your hands within an hour.

The contract to which I refer is NObs 20600, which is a contract which the Government entered into with Thomas Edison for the construction of these batteries.

Mr. Reilly: In 1943?

Mr. Arseneau: I would say it would go through 1944 or 1945.

The other material, if you will recall, obligated Defendant to forward letters to each of the contractors, asking for details on resins, binders, and so forth.

We have had a series of responses from some of the contractors, and we have made up copies of these documents, and I will introduce the letters.

[fol. 8] It might also be mentioned that some of the material mentioned in the memorandum overlaps material which we were to produce under the voluntary discovery stipulation.

Do you recall that?

Mr. Reilly: I recall that.

Mr. Arseneau: That was under Paragraph 3, and we expect to place in your hands copies of these letters, which are not specifically precluded by the stipulation or the terms of the pretrial memorandum.

Mr. Reilly: You are referring to Paragraph 3?

Mr. Arseneau: Are you referring to the pretrial memorandum?

Mr. Reilly: Yes, sir.

Mr. Arseneau: As referred to in Paragraph 3 of the pretrial memorandum.

Mr. Reilly: Drawings and sketches?

Mr. Arseneau: Yes, sir, and there is also a paragraph which suggests binders, resins, plastics and the like.

As I have pointed out, this does overlap, to some extent, what was shown in the voluntary discovery stipulation.

That is the group of material which we intend to place in your hands.

Mr. Reilly: I suppose we must be grateful for favors, as late as they may be. I do not want to appear to be ungrateful, but this is rather late. As far as these matters are concerned, I will look at them but I think that they are clearly [fol. 9] inadmissible because of the lateness of filing under the statute.

Commissioner Lane: The statute only refers to giving notice of the art relied on for anticipation and not the state of the art.

Mr. Arseneau: I will introduce Mr. Bernard Wohlfert of the Department of Justice, and I think his interpretation of Title 35 is in order.

Mr. Wohlfert: In so far as claims are concerned, we are obliged to give notice of anticipatory art, but in so far as state of the art is concerned, Title 35 does not require any thirty-day minimum notice.

Mr. Reilly: First I would like to know if this gentleman is an attorney?

Mr. Wohlfert: I am.

Mr. Reilly: Did you enter your appearance as an attorney in the case?

Mr. Wohlfert: I am with Mr. Arseneau.

Mr. Reilly: Are you admitted to practice before the Court of Claims?

Mr. Wohlfert: I am.

Mr. Reilly: We have a stipulation, as you will recall, of February 14, 1961, which provided for Defendant's attorney to provide Plaintiffs notice of prior art at least thirty days prior to trial.

[fol. 10] The matter referred to by Mr. Wohlfert has been modified by the stipulation between us. Therefore I will object to this as clearly inadmissible.

I would like to clear up one matter in the case.

As you may recall, at the pretrial there was a letter outstanding which noticed some 70-odd references and in the pretrial order Your Honor gave Defendant's counsel a time limit in which to notify Plaintiffs' counsel of the newly cited prior art with reference to what was relied upon, and that was to be done by June 22.

I have received a letter from Defendant's counsel in which he stated that he was withdrawing for purposes of anticipation a list of patents and references. I would like

to have that situation clarified, and I will ask, did that letter intend to be an answer to Paragraph 4, Your Honor, and may these items be eliminated from our case by Plaintiffs, and I assume by the Court for any purpose whatsoever?

Mr. Arseneau: Do you mind my asking you a question?

I will answer by saying that the art is set forth in the letter as omissions and deletions, and they are really omissions for any purpose, and having been excluded, we do not intend to apply them as prior art or state of the art references.

Mr. Reilly: In other words, Mr. Arseneau, the question I asked, so far as the art issue is concerned, then you have [fol. 11] no intention of introducing them?

Mr. Arseneau: If you are referring to the patents set forth in that letter, characterized as omissions, I have no intention of introducing them.

Mr. Reilly: That is clear enough.

Commissioner Lane: Do you want that list included in the record? I have a copy of that letter, but I don't know whether it is necessary or not.

Mr. Reilly: Yes, I would like to have it included in the record, Your Honor, and I thank you for the suggestion. May it be identified and offered as Trial Exhibit No. 20?

Commissioner Lane: It will be received.

(Letter dated June 22, 1961 from Department of Justice to Commissioner Lane was received in evidence as Trial Exhibit No. 20.)

Mr. Reilly: Your Honor, Mr. Arseneau has mentioned that he is planning to give us some time today further information concerning the construction of batteries made by contractors for the Defendant. He has stated that he wrote a letter to obtain that information.

I would like to have entered into the record whatever replies he receives, and ask that he offer them along with the letter requesting the same?

We are about to start the trial, and, as you know, up to this point the only information that we have had concerning [fol. 12] the alleged infringement are three physical batteries, which we have not been at liberty to take apart or

examine, and a series of letters which has gone in as Trial Exhibit No. 1.

These letters, Your Honor, are helpful to us, but they constitute only a small amount of information on which to try to predicate a finding of infringement.

However, the letters are changed, material crossed off, and much material is deleted.

I do not doubt that the Defendant's counsel has done that for the reason that much of the information contained therein is privileged, but I would like to ask that this Court order Mr. Arseneau and Mr. Wohlfert to deliver into Your Honor's hands the complete originals of the letters comprising Trial Exhibit No. 1, as well as the letters which were written to obtain this information in reply, so that Your Honor may examine it all and ascertain whether or not Plaintiff's counsel should be fairly advised of additional information which might be contained therein.

I assume there will be no objection to delivering them to Your Honor's hands?

Mr. Arseneau: The only objection I would raise is this, namely, that the letters are admittedly blanked, and the blanking was done in accordance with the terms of the stipulation, and there is a revealing of such information [fol. 13] as we desired, and it was agreed that Defendant would provide blank portions, or blocked-out portions of certain material Defendant will consider turning those letters over to inspection only by order of the Court.

Mr. Reilly: I should think, if I understand Mr. Arseneau's position, he is saying that everything which is blanked out has been properly blanked out, and Your Honor would see that and recognize the difficulty, and I should think Mr. Arseneau would want to turn them over to you.

Now I would request that you require him to do that.

Commissioner Lane: Any further comments, Mr. Arseneau?

Mr. Arseneau: No, I have already commented on the subject of these letters, Your Honor. I would, if I may, backtrack a little bit on the matter of turning over the blank letters included in the discovery material.

Mr. Reilly said some time prior to that that he wanted placed in the record items received from the contractors, and their comments, and also our request letters, and I

object very strenuously to making our letters a matter of record.

The pretrial memorandum said that the Defendant would look into and deliver, when available, to Plaintiffs' counsel drawings, sketches and so forth.

In some cases these were prolix and in some cases highly confidential, and some of this we are not prepared to turn over to Plaintiffs' counsel. However, we will turn over to [fol. 14] Plaintiffs' counsel anything that came back in the way of sketches, drawings or blueprints which came back and which we feel we can turn over, but there are blank spaces because some of this material they did not want to disclose. We have no objection to turning those over but I do not see any reason to turn over the letters that the Government sent to the contractors asking for additional information.

Commissioner Lane: I do not think we need the request until we see the replies of the contractors, and then we can determine whether or not the request needs to be exhibited.

With respect to Plaintiffs' request that the Court examine the complete originals of Trial Exhibit No. 1, the correspondence, to examine whether or not Trial Exhibit No. 1 includes everything contained in the stipulation, I am inclined to grant the request on the part of the Plaintiffs to have Defendant produce those.

Mr. Arseneau: Do I understand that the letters are to be turned over solely relating to the blanked letters?

Commissioner Lane: As I understand it, the request goes only to the correspondence contained in Trial Exhibit No. 1.

Mr. Reilly: That is correct, Your Honor.

Mr. Arseneau: My understanding of Trial Exhibit No. 1 is that it does contain the blanked letters of the contractors, given in response to the stipulation of February 17th.

Mr. Reilly: That is correct.

[fol. 15] Mr. Arseneau: Thank you very much.

Mr. Reilly: Do you have the originals here now?

Mr. Arseneau: No, but I will see that they get into His Honor's hands.

Mr. Reilly: Can you give me any time as to how long it will take?

Mr. Arseneau: I do not see any reason why we could not turn them over by tomorrow morning.

Mr. Reilly: How about after the luncheon recess? Your office is within a mile from here, is it not?

Mr. Arseneau: I have no objection to that.

Mr. Reilly: Now, Your Honor, may I introduce Richard A. Heuttner, who is associated with my firm, and may I introduce him to Mr. Wohlfert and to Mr. Arseneau?

I would like to move his appearance for the purpose of this case, so that he may be free to examine witnesses and so forth.

Commissioner Lane: Mr. Heuttner may appear for such purpose.

Mr. Heuttner: Thank you, Your Honor.

Mr. Reilly: We have one other small matter with respect to Trial Exhibit No. 12, which Your Honor has up there, and we are going to use that in some of our testimony, and I think it might be helpful if we marked the pages in it, Mr. Arseneau, and so that they will agree with the pages of [fol. 16] the copy which has already been marked, and if you do not mind, and if you will agree to it, Mr. Arseneau, I would like to have the copy of Trial Exhibit No. 12 marked during the luncheon recess to correspond to the page numbers. Is that agreeable?

Commissioner Lane: If Defendant has a copy of Trial Exhibit No. 12, it may be marked.

STATEMENT ON BEHALF OF PLAINTIFFS BY MR. REILLY

Mr. Reilly: Now, Your Honor has indicated that openings can be dispensed with, and I agree with you that most of the time an opening is useless. However, I would like to make a short statement to clear up the possibility of confusion as to what our case consists of.

As Your Honor has said, this is a patent suit. It is also a breach of contract suit, Your Honor.

I would like to cover briefly what our testimony will be about, so that the Court maybe advised of the substance of it as the case progresses.

Before the outbreak of World War II, as everyone knows, the Government of the United States issued an invitation through the National Inventors Council, and through various other agencies, for inventors and people with ideas that

might be of help at that time to come forward and submit ideas or invention to the Government.

This is in the nature of a unilateral contract with a condition subsequent.

[fol. 17] Many inventors and people with ideas, whether patented or not patented, did come forward and make disclosures to the Government. In this particular case, when a disclosure is made; there is acceptance of the offer, and the contract is then completed. No legal obligation arises at that time whatsoever, and does not arise unless and until the condition subsequent is fulfilled, and that condition subsequent is the use by the Government of any submitted disclosure.

If the Government uses such a disclosure, the condition subsequent is fulfilled, and then the only remaining question is, what is fair payment?

We shall prove that Mr. Adams made a full and fair disclosure to the National Inventors Council, to the Navy and to the Army Signal Corps of the details of his battery system, and how it worked, and what its characteristics were, and all the unusual uses to which it could be put as a novel source of power.

We shall show that the Government subsequently used the disclosure and made use of these batteries, and has done so in the type of use as Mr. Adams pointed out to them.

Now the claim should have been negotiated, but since it was not, this suit was filed and carries with it a claim for breach of contract, in connection with this contract which I have just outlined.

I would like to point out at this point, for purposes of [fol. 18] clarity, that this claim, this obligation on the part of the Government, is not barred by the statute of limitations for several reasons.

First of all, in the voluminous correspondence with Mr. Adams, most of which is stipulated in the record, you will find the details of Mr. Adams' disclosures set forth with some particularity.

You will also find continuing requests from the Army, particularly the Army Signal Corps and the Naval Research and Development Laboratory for Mr. Adams to return and supply them with additional batteries and more batteries and more batteries, and there is a letter where they re-

quested him to bid on batteries which he was to supply, and this went on for quite a bit of time.

At some point they wrote him several letters, one from the National Inventors Council and one from the Chief of the Army Signal Corps, I believe, or the Chief Officer, in which they advised him that he would be informed by the National Inventors Council of the results of the appraisal of his disclosure.

The letter from the Chief of the Signal Corps informed him that he would be informed of the results of the low temperature tests and normal temperature tests on the various batteries that he had submitted.

Mr. Adams, until the date that this suit was filed some [fol. 19] fifteen years later, never in the meantime was advised of the results of one test or appraisal.

Secondly, the cause of action did not accrue until the violation became known. It is not easy to obtain information on what the Army or the Defendant is doing with such batteries. Now the point is that I am standing here before you this morning and I am still hoping to get some detailed description of what the alleged infringing batteries amounted to, and this is many years later.

Third, the cause of action did not accrue until the Plaintiffs knew that the Army was using the disclosure and made a demand, and it had to be rejected before one could sue.

So that is the reason why there is a breach of contract here.

I would briefly like to outline the elements of the patent side of the case, if I may.

As I said at the pretrial conference, this is going to be an unusual patent case, not because we say it is a pioneer invention but because I think we are going to prove it. Secondly, to determine whether a pioneer invention exists or not, you have to know what is old in the art. I would like to say that the art shows that the physical form of the battery, the specific battery disclosed in the Adams patent, is old in the art, the round battery, the use of cylindrical [fol. 20] electrodes, the central electrode being a solid cylinder, and the arrangement of those parts is old in the art.

These batteries, an inspection shows, taking Exhibit No. 7, Your Honor, for example, that they are flat plate type bat-

teries, and Exhibit No. 7 is probably put together in the same way as Exhibit No. 8, which may be a little more open.

There you have a flat plate or electrode of magnesium, and another flat plate or electrode, presumably of cuprous chloride, separated by a piece of water-absorbent paper or cardboard.

It is very interesting to look at the historical viewpoint for a moment. I have here a copy of a book entitled "Primary Batteries," by George Wood Vinal, published in 1951, and referring to pages 2 and 3 of this document, and it tells about Volta and a report he made in 1800, as to how he made his first battery by having flat plates of silver and zinc, and between them he placed discs of pasteboard well soaked in water.

Your Honor, here is a sketch by Mr. Volta, the famous Volta who invented the battery, and you see on page 2 there his original hand-written sketch, and then on page 3 is the drawing more clearly defined.

Each one of these little cells is a piece of zinc and a piece of silver, between which a piece of paper is placed which is soaked in water.

[fol. 21] Then Volta did not use water again because it did not operate effectively, and he went ahead and used electrolytes. As he says:

> "Between adjacent pairs of dissimilar metals he placed discs of pasteboard ('carton'), animal's hide, or other porous material well soaked in water or 'some other fluid which may be a better condutor than simple water, as salt water, lye, etc.'"

From then on up until 1940, the art used only electrolytes, and by electrolytes I mean better conductors than simple water, such as salts, acids, alkalies, and so forth.

That has been the history of batteries for about 120 or more years.

The other constituents in the art which are old are the methods of making electrodes. It was old by 1860 or 1880, to take a powder such as silver chloride and melt it around a piece of coiled wire and make an electrode of it.

It was also old about the same time to make a water paste of the same substance, or equivalent substances, and spread them on metal or grid material to make electrodes.

It was also old to make electrodes by pasting the reactive material onto a grid, making a paste by adding resins or binders and solvents to the mix to melt the mix and then to solidify it in order to increase the strength of the electrode. [fol. 22] These were old in the art for some time and later on when plastics, as we now term them, came into existence, they were used to unify the material for electrodes, and they were all known before Adams.

What else was old? We have covered the construction of the batteries, the size and shape of the plates and the way in which electrodes are made.

What else is old? Silver chloride is old and was well known in the art as a material for making electrodes. Cuprous chloride is old in the art and was well known as a material for making electrodes. Carbon has been used for better than 100 years as a material for making electrodes.

Magnesium was first discovered, I believe, or made in pure form somewhere about 1856. It really became commercially available in Germany in about 1900, and it became commercially available in large quantities in this country during World War I, and ever since discovered it has been recommended as a material for electrodes in batteries. Water is old, and, as I pointed out, it represented Volta's initial battery experiment.

What is left? Only the battery system, the system consisting of the magnesium anode, a cuprous chloride cathode, with the use of any kind of water, including distilled water, which, as Your Honor knows, is not only a non-conductor but is in fact an insulator.

[fol. 23] That is one system. The second system covered by Adams is the magnesium anode, the cuprous chloride cathode, plus carbon and water, any kind of water.

The third system covered by Adams is brought in by the doctrine of equivalents, and is not specifically disclosed in the patent. It is the system of silver chloride, magnesium and water.

As we said in our pretrail conference, Your Honor, our position is that silver chloride is the equivalent of cuprous chloride and carbon in this battery system.

Your Honor will find that the number of Defendant's references is now down below 50, and we do not have more than 1,000 pages. Nowhere in those references will you find

any of the three systems which I have just described, which date before Adams.

I want to point out briefly the impact of this, Your Honor. Everything used in the patent in suit by the inventor Adams was old in the art by 1880 at the latest.

Adams made his invention some time around 1939. Sixty years went by, with these materials sitting in the laboratory, and with a great amount of scientific research being done in the field of batteries. The making of the electrodes was discovered in the previous century. Why did 60 years go by before somebody put these three simple components together to produce a battery which we will prove has characteristics which are different than any prior art battery? [fol. 24] The answer is because the art was pointed away from any understanding of this battery system, and the more art the Defendant introduces, the clearer that will become.

This meets the positive test of Judge Learned Hand, Your Honor, as to what constitutes a pioneer invention. It is the converse of the thought that you find expressed in Section 103 of the Patent Act of 1952. The objective test is if you can find that there existed in the art, that is, all the materials were available which were used by the inventor in making his system, and that a need existed, a long felt want existed during this period for the invention he produced. Then he is the inventor, and if the period of time has been long enough, and if the invention has those appropriate characteristics, he pioneered.

Your Honor, when Mr. Adams went to the Army to talk to them about the battery he had, and when you look at the correspondence you will see that they were laughing at him, and justifiably so. I do not want anyone to get the impression that I am pointing a finger of derision at anyone in the Army battery field.

The reason they laughed at him was because the story he was telling was unbelievable in terms of the batteries that they were familiar with.

As you look at it today, you can see that quite clearly. [fol. 25] For example, Mr. Adams supplied battery performance curves and the tops of the curves are level, and they are flat, and they look like they were drawn with a straight edge ruler, and even Doctor Vinal, who is one of

the most respected authorities in the field of batteries, criticized Adams and said: "This man does not know how to draw a curve, he uses a rule. What battery has a flat curve not only for amperage but for voltage?"

The interesting thing is that when you look at the articles published in 1946 through 1955 by the people who supplied Defendant with their batteries, you will see that the tops of all of their curves look like that.

What other characteristics did this battery have which added to all the other characteristics sounded unbelievable?

The first thing which was wrong with it, in the opinion of the experts at that time, was that it had an exothermic reaction. Every prior art battery, when it began to boil over and heat up, was going wrong. No one appreciated that when Adams said that his batteries worked at −50° Centigrade that it was this exothermic reaction, which they thought was a disadvantage, which permitted a water-activated battery to operate at −50° Centigrade. When they said that the water would freeze, if it was not heated up by some means, and Adams said: "My battery will go to −50° Centigrade because there is this boiling. They said "ridiculous."

The battery had these features which we will detail, and [fol. 26] taking the total of them you will find no other battery in existence as of that time which had all of them. Indeed, Your Honor, there is none today, even though a new industry, I might say, has been founded to manufacture this type of battery, there have been no important discoveries of new systems embodying Adams' principles.

I would like to point out that the men who laughed at Mr. Adams in 1943 are filing claims in 1950, and up to date, on the same type of system. The scoffers have now caught up with him.

Why has not the Adams system been improved on? Why has not someone discovered a different type of battery, using the same scientific principle?

The answer, Your Honor, is fully recognized by the important researchers in the field today; that today there is no scientific theory which explains the electrochemical reaction which takes place in what they themselves term the complex system of the magnesium-cuprous chloride-water battery.

Neither the chemical reactions nor the electrical reactions,

nor the ionic reactions are understood. The reaction products are not clearly identified and the reaction products are formed by the inter-action of these substances in a way that is still mysterious.

So that from the art today you will find that every [fol. 27] invention being made today is admitted to be on an empirical basis. That much is known, and you accept it and you don't try to reason back to theory.

Of course, Your Honor, it is obvious that if there is no theory available today to explain the process of the Adams battery, then there was no theory in 1940 which would forecast its operability and point out anything in the direction of making it.

Your Honor, I would like to say as to the patent in suit, that you will be told that every claim of the patent in suit contains the word "fused" and that "fused" has reference to the making of the cuprous chloride into a cathode, and that the one means of "fusing" which you will be told about is that it means only a heat process, melting by heat process, as detailed in the single illustrated embodiment shown in the Adams patent.

You will also be told that Adams voluntarily limited his patent to "fused" and therefore he cannot now move one jot or tittle from it.

Adams shows one form of battery as an illustrative embodiment, and he uses heat to make the electrode. He melts cuprous chloride by heat, and he calls it "heat." He tells you why he uses the heat. He does it so that he can pour the material into a mold. He also uses the word "fused" and the use of that word in his description makes it perfectly [fol. 28] clear that Adams' meaning of the word "fused" is broader than his meaning of the word "heat," and that "fused" is a generic expression meaning "unified" or "blended and unified."

As I have already said, all of the methods of making electrodes which the Defendant's contractors apparently used are known and old in the art, 60 years before Adams. Adams' specific method was old too. This is not a method patent and it is not a mechanical patent. It is a product patent and it is an electrochemical patent, and the processes used by the contractors all take the material such as cuprous chloride and they unify it and melt it by heat, or they melt

it with water, or if they do not melt it with water, they melt it with organic solvents, and then add a resin to bind it back together and gain some of the strength characteristics which it lost when melting it with water alone. The process is one of unification.

I would like to refer briefly to the doctrine of chemical equivalents. The doctrine of chemical equivalents cuts two ways, Your Honor, as the Supreme Court has pointed out in Graver v. Linde. Every patent is entitled to be subjected to the doctrine of equivalents because the doctrine of equivalents is not only used to protect claims but it is used to anticipate a patent. If you find a patentee discloses compound X but compound Y is old in the art, and Y and X are equivalents, then the patent on compound X may be invalidated because of the doctrine of equivalents. So the [fol. 29] doctrine of equivalents is a two-way sword.

We say that the Adams patent mentions only cuprous chloride specifically. Defendant has cited volumes of silver chloride references. Why? Because he is depending on the doctrine of equivalents, and he is saying that silver chloride works like cuprous chloride in this system, and if silver chloride is old, this system falls because they are equivalents and that if silver chloride water-activated batteries were invented before Adams, Defendant should win.

But having taken that position, that silver chloride anticipates, the oldest maxim in the patent book is that that which anticipates if earlier, infringes if later.

Defendant cannot say: "We have cited silver chloride against these batteries but you cannot use that to show it infringes."

He must eat the cake or leave it.

We feel that the doctrine of equivalents should be applied here uniformly across the board. We say that this patent is entitled to a reasonable range of mechanical equivalents inasmuch as it is a chemical patent and it has nothing to do with any physical structure or physical methods of making the substance, and that the method used by the Army contractors to produce their electrodes acts in exactly the same way, to produce exactly the same results as that used by [fol. 30] Adams on his electrodes.

We also say that silver chloride is an equivalent and, as Your Honor knows, silver chloride was used in batteries as

well as magnesium, cuprous chloride and water before Adams used them. The doctrine of mechanical equivalents, and the doctrine of chemical equivalents should be applied uniformly to the patent, either with respect to anticipation or to determine the scope of the claims as to which there may be infringement, and let the chips fall where they may.

Thank you very much, Your Honor.

Commissioner Lane: Does Defendant have any opening statement?

Mr. Arseneau: Only that I prefer to rely on the testimony of my witnesses.

Commissioner Lane: Very well. We might have a ten-minute recess before starting the testimony.

(Short recess.)

Commissioner Lane: You may proceed.

Mr. Reilly: The Plaintiff will call Mr. Adams to the stand.

Whereupon Bert N. Adams, a witness produced on behalf of the Plaintiffs, being first duly sworn by said Commissioner, was examined and testified as follows:

[fol. 31] Direct examination.

By Mr. Huettner:

Q. Will you please state your name and address?

A. Bert N. Adams, No. 6 East Street, Hicksville, New York.

Q. Are you one of the Plaintiffs in this suit, Mr. Adams?

A. Yes.

Q. Where were you born and in what year?

A. At New Rochelle in the year 1900, October 4th.

Q. Where did you first receive your education, Mr. Adams?

A. New Rochelle, New York, Philadelphia and Erie, Pennsylvania.

Q. Did you graduate from high school, Mr. Adams?

A. Yes.

Q. Where was this?

A. In Erie, Pennsylvania, in 1915.

Q. After you graduated from high school, what did you do?

A. I went to General Electric as an apprentice for approximately one year.

Q. What kind of an apprentice?

A. Machine shop.

[fol. 32] Q. What did you do after you were an apprentice for General Electric?

A. The war broke out and I tried to enlist in the Navy but I was rejected so I enlisted in the Merchant Marine, where there were no physical requirements.

Q. How long did you remain in the Merchant Marine during the war?

A. We went into war and I stayed until 1920.

Q. What did you do after 1920?

A. I went back to Italy, where we were. They brought the troops to Italy and I went to the Milan Didactic Institute, and enrolled.

Q. Where was the Milan Didactic Institute?

A. In Milan.

Q. Italy?

A. Yes, sir.

Q. After spending four years at the Didactic Institute, what did you do then, Mr. Adams?

A. I came back home and worked for the United States Salvage Company, a marine salvage company in Florida.

Q. How long did you work the the United States Salvage Company?

A. After the year of the crash.

Q. Then what did you do?

[fol. 33] A. Then I went to Briggs Shipyard and worked on rebuilding the diesels on some of the destroyers and other ships.

Q. During the depression years and the year of the crash, did you have other jobs?

A. Yes, I took any job which came along, automobile repair and radio and painting.

Q. Then did you get any other position, Mr. Adams?

A. I did, in the spring of 1939 at the World's Fair.

Q. For whom did you work?

A. I worked for Breda Steel Company.

Q. When did you start working for the Breda Steel Company?

A. In the spring of 1939.

Q. How long did you work for them?

A. I worked for them until 1941, until the closing of the Fair, when they packed up the exhibit.

Q. What Fair are you referring to?

A. The World's Fair.

Q. Where was it held?

A. What?

Q. Where was it held?

A. It was held in Flushing Meadows.

Q. In New York?

A. In New York.

[fol. 34] Q. When did you first become interested in the general field of batteries?

A. In the summer of 1939.

Q. What did you first do when you became interested in batteries?

A. I studied the theories, various theories of it, and started to experiment with various metals, such as iron and copper and zinc.

Q. What kind of metals did you experiment with, and for what purpose?

A. I was trying to find a b[illegible]tery which had a linear potential and could be activated with water, and I experimented with these various metals, including aluminum, magnesium and cuprous chloride, and silver chloride, and in fact I even tried gold chloride.

Q. For what purpose did you experiment with these metals?

A. For the purpose of trying to find a battery which was a better battery than we had, with a primary cell.

Q. Why did you want to activate batteries with water?

A. The reason is water is not corrosive, and it would affect with less resistance any anode or cathode that I had.

Q. Were you generally familiar with the electrical properties of water?

[fol. 35] A. Yes.

Q. What did you know about the general electrical properties of water?

A. Water has a very high resistance, normal faucet water, 200,000 ohms per centimeter.

Q. Would you say water would be a good or bad electrolyte?

A. A good electrolyte.

Q. What materials did you experiment with for your electrodes in the battery?

A. With various materials, including aluminum, zinc, and finally with magnesium for the anode, and copper, steel and other metals for the cathode, and cuprous chloride and cupric chloride.

Q. What material did you finally settle upon for your anode?

A. Magnesium for the anode.

Q. Why did you settle on this?

A. Because magnesium has a high electromotive force.

Q. What kind of a reaction did you find between water, which you had decided upon, and the magnesium, as the reaction between those two?

A. Between water and magnesium?

[fol. 36] Q. Yes.

A. That magnesium is slightly soluble in water.

Q. What materials did you settle upon finally for your cathode?

A. The cuprous chloride.

Q. When you combined the magnesium anode in a unit which had a cuprous chloride cathode and the electrolyte as water, what did you find?

A. It showed a voltage.

Q. And when you had a voltage, what did that indicate to you?

A. It indicated that I had a battery.

Q. Did you try other materials besides cuprous chloride for your cathode?

A. Yes, I did. I tried cupric chloride.

Q. Did that work?

A. No. I tried steel and I tried copper.

Q. Did that work?

A. No.

Q. Did you try any other metals?

A. I tried other metals. The only thing which did work was silver chloride and gold chloride.

Q. You tried those?

A. Yes, sir, I tried those.

[fol. 37] Q. Why did you select cuprous chloride in preference to silver or gold chloride?

A. Because it is cheaper and has the same effect.

Q. Mr. Adams, when did you come up with the first operative battery which had these three materials that we have previously mentioned, namely, a magnesium anode, a cuprous chloride cathode, and activated by water?

A. In the summer of 1939.

Q. How do you remember that it was in the summer of 1939?

A. The war had broken out then.

Q. Which war?

A. The Second World War between Germany and France. At that time we were not in it.

Q. Did you continue experimenting later on or after this with your battery?

A. I did.

Q. Mr. Adams, I will hand you two documents, one being a duplicate of the other, which I would like to have marked for identification.

A. Yes, sir.

Mr. Huettner: Your Honor, do we continue with the Trial Exhibit numbers or start with regular numbers?

Commissioner Lane: I think we better mark them as [fol. 38] Plaintiffs exhibits.

(Two sheets of invoice headed "Date Shipped 2-2-40 From Midland, Michigan, in re Dow Metal M Sheets CP .040" and .020" was marked for identification as Plaintiffs' Exhibit No. 1.)

By Mr. Huettner:

Q. I show you Plaintiffs' Exhibit No. 1 for identification and ask you if you received the invoices that you have before you?

A. I did.

Q. When did you receive these invoices?

A. February 2, 1940.

Q. On or about that date?

A. Yes, sir.
Q. How did you receive this invoice?
A. With several sheets of magnesium.
Q. From whom did you receive it?
A. From Dow Chemical Company.

OFFERS IN EVIDENCE

Mr. Huettner: Your Honor, I ask that this exhibit be introduced into evidence as Plaintiffs' Exhibit No. 1.

Commissioner Lane: Any objection, Mr. Arseneau?

Mr. Arseneau: No objection.

Commissioner Lane: It is received in evidence as Plaintiffs' Exhibit No. 1.

[fol. 39] (The document heretofore marked for identification Plaintiffs' Exhibit No. 1 was received in evidence.)

By Mr. Huettner:

Q. Mr Adams, referring to Plaintiffs' Exhibit No. 1, what was this an invoice for?
A. For sheets of magnesium.
Q. Why did you want magnesium on or about February 1940?
A Because I had used all the magnesium and I had to buy some more in 1940 to make batteries.
Q. Did you make subsequent purchases of magnesium?
A. Yes, sir.
Q. Mr. Adams, did you find the batteries that you made back in the late summer of 1939 completely satisfactory?
A. No, I did not.
Q. What did you find that was unsatisfactory?
A. The current was low.
Q. Did you experiment to try to improve this condition?
A. I did.
Q. What did you do?
A. Well, through an accident I found a catalyst carbon.
Q. How did this accident occur?
A. I was smoking a cigarette and I put the cuprous chloride in a crucible, and the ashes fell in. In those days, [fol. 40] not having any place where I could throw the mix away, I just cooked it or blended it and made a battery with the cathode, with the cuprous chloride, and found that that

had current, large current. I tested it and it had large current.

Q. When did this incident occur, Mr. Adams? Do you recall?

A. This incident occurred around the end of 1939.

Q. Do you recall where you were living at the time when this incident occurred?

A. With Shulens.

Q. Do you recall when you moved to the home of the Shulens or to the house owned by the Shulens?

A. That was roughly in the summer of 1939, and to December 1, 1939. That is to the best of my recollection. I may be wrong on the year. Dates are difficult.

Q. Mr. Adams, you say that you dropped some cigarette ash into a crucible in which you were cooking some cuprous chloride?

A. Yes, sir.

Q. Did you use the cuprous chloride which you were cooking, into which the ash fell, to make an electrode?

A. Yes, sir.

Q. Did you use this electrode in one of your batteries?

A. Yes.

[fol. 41] Q. Did you make an operable battery with this contaminated electrode?

A. Yes.

Q. Did you test this battery?

A. Yes.

Q. What were the results of the test?

A. I had a good battery. I had a battery which lit the bulb.

Q. Did you notice any other results obtained from this battery?

A. The linear potential.

Q. What do you mean by that?

A. The potential was flat. In other words, you have a curve that goes like so (indicating), and then it comes down at the bottom. We call it a flat curve.

Q. What is linear potential?

A. Linear potential is a potential that remains straight under load.

Q. Mr. Adams, after you made this battery with the contaminated electrode containing carbon, what did you do next?

A. I started thinking what had happened, and the only reason I could give was that the carbon must be a good thing in it, and I went out and bought charcoal, and I got [fol. 42] pieces of hard coal—we used both—and I got metallurgical coal, and I tried powdered graphite and I found out regardless of the type—and also sugar, and I put in sugar, which is a hydro-carbon, and I found out that the carbon is the catalyst that gave me the current.

Q. Did you make electrodes out of all these various kinds of carbons?

A. Yes, sir, I did.

Q. Did you put them into batteries?

A. Yes.

Q. Did you test them?

A. Yes.

Q. What were the results?

A. The results were that all came out the same.

Q. Were they good or bad?

A. They were good batteries.

Q. Mr. Adams, I give you two pieces of paper. The first piece contains some handwritten notes, with some figures and a graph, and the second page is typewritten, containing a handwritten notation showing the date August 29, 1940. Do you recognize these papers?

A. I do.

Q. Is the handwriting and are the figures and the graphs on the first page in your handwriting?

[fol. 43] A. It is.

Q. Is the handwriting that shows the date August 29, 1940, on the second page, in your handwriting?

A. It is.

Q. Was the second page typewritten by you?

A. Yes.

Q. I note on the first page, Mr. Adams, that there are some dates, August 26—and I am referring to the upper right-hand corner—and below that August 27, and then in the middle of the graph it shows August 28th. What year do those August dates refer to?

A. 1940.

Q. Why do you say that, Mr. Adams?

A. Because I recall it, and the second page was typed at that time, and it states so.

Q. In other words, Mr. Adams, did you type the two pages and then sign it?

A. Yes, sir.

Q. With the date, after you had typed it?

A. Yes, sir.

Mr. Huettner: I would like to offer into evidence as Plaintiffs' Exhibit No. 2 the graph and the typewritten page which the witness referred to.

Mr. Arseneau: Your Honor, I would like to object to this as [fol. 44] being self-serving and not proved. The graph sheet has no year but only the month, and the sheet which has the year, or supplies the year, is partially typewritten and partially handwritten.

Mr. Huettner: Your Honor, I think the witness testified to the fact that the August 26, 27 and 28 dates which appear on the first page are 1940, and that sheet 2 is only a summary, which you will see very clearly, Your Honor, where the time and date of water added to the battery was 8:15 p.m., August 26, 1940, which was for the first time, Your Honor, indicated on sheet 1, and that the time of stopping current drain was at 9:30 a.m., August 29, 1940, which is where the graph comes to the end at the bottom. The witness, who wrote the first page, testified that he wrote the second page on August 29th, which summarizes the graph on the first page. I do not think there is any question about that here.

Commissioner Lane: Mr. Arseneau, if you like, you may reserve further objection until you have had an opportunity to cross-examine Mr. Adams.

Mr. Arseneau: Thank you, Your Honor.

Commissioner Lane: It will be marked Plaintiffs' Exhibit No. 2 for identification at this time, and I will rule on its admissibility after cross-examination.

[fol. 45] (Two-page document the first of which shows a curve and the second of which states "Summary of Test of Original Cell August 29, 1940," marked for identification as Plaintiffs' Exhibit No. 2.)

By Mr. Huettner:

Q. Mr. Adams, what is shown on page 1 of Plaintiffs' Exhibit No. 2, which is the document containing the graph?

A. A curve which shows the potential, the various loads.

The top one is the potential of the battery open circuit, and the other is the potential of the center with the two-volt load, and that shows the characteristic of the bulb which I used as lead.

Q. What kind of a battery does this graph represent?

A. A battery made of magnesium anode and a cuprous chloride cathode, blended with carbon and a water electrolyte.

Q. When did you add the water electrolyte to this battery?

A. At the time of activation. It was at 8:15 p.m. on August 26, 1940.

Q. Did you continue to make readings during August 26, 1940?

A. Yes, as stated on this curve.

Q. What are you pointing to there, Mr. Adams?

[fol. 46] A. At the time, on August 26th and on August 27th and on August 28th.

Q. Do we go into August 29th? Did this continue on into August 29th?

A. Yes, sir.

Q. Will you refer to page 2 of Plaintiffs' Exhibit No. 2 for identification?

A. Yes, sir.

Q. How long did this battery operate, Mr. Adams?

A. Roughly 34 hours.

Q. In view of the objection of Mr. Arseneau, would you repeat what page 2 is with reference to page 1?

A. Page 2 is a summary of page 1.

Q. Mr. Adams, I would like to refer you again to this exhibit, Plaintiffs' Exhibit No. 2 for identification. Was this one of your earlier batteries?

A. Yes, sir.

Q. You said this battery contained a cuprous chloride cathode which had carbon in it?

A. Right.

Q. Was that one of the first of such batteries?

A. Yes, sir.

Q. Earlier you said that this addition of carbon which you accidentally made when smoking a cigarette took place [fol. 47] in the year 1939?

A. Yes, sir.

Q. I would like to have you refresh your recollection, in

view of this document which is before you, and I ask you whether it was in the year 1939 or 1940 that the accident happened?

A. It was either late—when I said the first time, it was either late 1939 or in 1940. It is difficult for me to pinpoint the exact time within those dates.

Q. Mr. Adams, did you continue experimenting with your battery after August 29, 1940?

A. I did.

Q. Did you experiment with regard to chemicals or anything of that kind to increase the speed of activation of the battery?

A. I did.

Q. What did you do in this respect?

A. I added magnesium chloride.

Q. And did you test the batteries in which you had added the magnesium chloride?

A Yes.

Q. What were the results?

A. I gained a slight bit in the activation time.

Q. Did you do any experiments with regard to contami-
[fol. 48] nation of the electrodes?

A. Yes.

Q. What were the results of your experiments?

A. I added magnesium sulphate in that case and kept the electrodes cleaner.

Q. Mr. Adams, I hand you a document entitled "N.Y. March 13-14 1941." Do you recognize this document?

A. Yes, I typed it.

Q. You typed this document?

A. Yes, sir.

Q. Did you type the information and draw the graph contained thereon?

A. Yes.

Q. Did you do it on or about the date March 13-14, 1941?

A. Yes.

Mr. Huettner: I offer this document into evidence as Plaintiffs' Exhibit No. 3.

Commissioner Lane: Any objection, Mr. Arseneau?

Mr. Arseneau: No, sir.

Commissioner Lane: Plaintiffs' Exhibit No. 3 is received.

(One-page document headed "N.Y. March 13-14 1941 Capacity Test of Neutro Cell" was received in evidence as Plaintiffs' Exhibit No. 3.)

[fol. 49] By Mr. Huettner:

Q. I direct you attention, Mr. Adams, to the bottom of this document. Does this document show the addition that you just mentioned of magnesium sulphate and magnesium chloride?

A. Yes.

Q. Did this cell operate properly?

A. Yes.

Q. Was it a good cell?

A. Yes.

Q. I note on the top, Mr. Adams, that you say "Neutro Cell." What is a "Neutro Cell"?

A. It is the name I gave to this particular cell made of magnesium, cuprous chloride, carbon and water.

Q. In other words, that is the name you gave to identify your cell?

A. To identify the cell which had a practically neutral electrolyte.

Q. Whenever we see the word "Neutro" anywhere in the documents, you are referring to a cell which has a magnesium anode, a cuprous chloride cathode and activated by water?

A. That is correct.

Q. Mr. Adams, I hand you a physical object which looks like a glass jar, having a black-rimmed seal at the top, with [fol. 50] two pieces of metal protruding out of the top. The glass contains a faded brown label which is dated at the bottom either May or November—it is undistinguishable—21, 1941. Do you recognize this cell?

A. Yes, sir, it is one of my early cells.

Q. What is the anode made of?

A. Magnesium.

Q. What is the cathode made of?

A. Cuprous chloride, blended with carbon.

Q. What was the electrolyte used in this cell?

A. Water.

Q. Is it a used cell and has it been spent?

A. This has been spent.

Q. Is this cell similar to the cells which we have been discussing up to this time?

A. Yes, sir.

Q. Did you make this cell, Mr. Adams?

A. Yes, I did.

Q. Did you make it on or about the date on this label?

A. Yes, sir.

Mr. Huettner: I offer this cell in evidence as Plaintiffs' Exhibit No. 4.

Mr. Arseneau: Excuse me. Did you refer to the label?

Mr. Huettner: On the very bottom line is the date which [fol. 51] I gave as November 21, 1941.

Mr. Wohlfert: If Your Honor please, I think at this point it might be well to make a general objection to the nature of the questions asked by counsel for the Plaintiffs. I note that almost every question has been answered by yes or no, in view of the leading nature of the questions. I think the witness should identify these exhibits and tell us what they are and not have counsel prompt him with leading questions.

Mr. Reilly: May I interject? I would like to have proper procedure followed by Defendant's counsel. You will observe that on our side one counsel has conducted the examination, and I have not interjected up to this point. I think we better make up our minds who is going to object, and either one or the other do it, and not both.

Commissioner Lane: Will you bear in mind the objection of Plaintiffs' counsel, Mr. Wohlfert?

Mr. Wohlfert: Yes, Your Honor.

Commissioner Lane: Proceed.

Mr. Huettner: My last request was that this battery be introduced into evidence as Plaintiffs' Exhibit No. 4.

Mr. Arseneau: I object, Your Honor.

Commissioner Lane: It will be marked and received.

[fol. 52] (Physical exhibit, being glass jar, dated November 21, 1941, with magnesium anode and cathode of cuprous chloride, blended with carbon, was received in evidence as Plaintiffs' Exhibit No. 4.)

By Mr. Huettner:

Q. Mr. Adams, did you make other shapes of your neutro cell?

A. Yes.

Q. Mr. Adams, I place before you five objects, starting from left to right, and would you identify those objects?

A. These are cells that I made in the following rotation, yes, sir. (Indicating)

Mr. Huettner: The witness has placed the cells in a certain order.

By Mr. Huettner:

Q. When you say "in the following rotation," would you please explain that?

A. This was made, I am sure, after this date. (Indicating)

Mr. Huettner: When the witness is saying "this," he is pointing to a tubular object about four inches long, and I would like to have this marked for identification so that we will know what we are talking about. It will be Plaintiffs' Exhibit No. 5 for identification.

[fol. 53] (Physical exhibit, being a tubular object about four inches long, was marked for identification as Plaintiffs' Exhibit No. 5.)

By Mr. Huettner:

Q. Proceed, Mr. Adams.

A. This was made on the request of the Signal Corps, which wanted a Type D, which denotes the size of the battery. (Indicating)

Mr. Huettner: The witness just picked up another cylindrical object which has two wires attached to it, and I would like to have that marked as Plaintiffs' Exhibit No. 6 for identification.

(Physical exhibit, being a cylindrical object with two wires attached was marked for identification as Plaintiffs' Exhibit No. 6.)

The Witness: This one with a high-amperage battery gave 1.2 amperes at 1.5 volts. (Indicating)

Mr. Huettner: The witness has just pick up a glass object which has a label on it, and I would like to have this marked for identification as Plaintiffs' Exhibit No. 7.

(Physical exhibit, being made of glass with a label on it dated 1943 was marked for identification as Plaintiffs' Exhibit No. 7.)

[fol. 54] By Mr. Huettner:

Q. Does the label on that battery have a date?

A. It has 1943 for this particular battery, but they were made before this date.

Q. The next object, Mr. Adams?

A. The next one is for extremely high amperage, with the thought of missiles in mind. This was flat. There are three cells in series, capable of delivering 14 amperes in a time of four minutes at 1.1 volts (indicating).

Mr. Huettner: The witness was just talking about a rectangular-shaped article which I would like to have marked as Plaintiffs' Exhibit No. 8 for identification.

(Physical exhibit, being a rectangular object, was marked for identification as Plaintiffs' Exhibit No. 8.)

By Mr. Huettner:

Q. Proceed.

A. The next one is an improved design of a venting system for use in aircraft, and it has a novel type valve.

Q. The Plaintiff is now discussing a plastic cylinder article, which I would like to have marked Plaintiffs' Exhibit No. 9 for identification.

Is that correct?

A. Yes, sir.

[fol. 55] (Physical exhibit, being plastic cylinder, was marked for identification as Plaintiffs' Exhibit No. 9.)

By Mr. Huettner:

Q. Who made the cells in front of you, Mr. Adams?

A. I made all these cells.

Q. Approximately when did you make the cells marked Plaintiffs' Exhibits Nos. 4 and 5, the ones on your right?

A. They were made early in 1942.

Q. When did you make cells marked Plaintiffs' Exhibit No. 6, which is the next one?

A. They were made at approximately the same time.

Q. Plaintiffs' Exhibit No. 7?

A. These were also made at that time for experimentation on high amperage.

Q. And Plaintiffs' Exhibit No. 8?

A. These were made probably in the early part of 1943.

Q. And Plaintiffs' Exhibit No. 9?

A. These were made just about the same time.

Q. Did you deliver any one of these cells to the Army?

A. This type, the first and second.

Q. You are talking about Plaintiffs' Exhibits Nos. 5 and 6?

A. Plaintiffs' Exhibits Nos. 5 and 6 and 8 and 9 were [fol. 56] delivered to Fort Monmouth.

Mr. Huettner: I would like to introduce into evidence physical Exhibits Nos. 5, 6, 7, 8 and 9.

Mr. Arseneau: I have no objection, Your Honor.

Commissioner Lane: The will be received in evidence, and they will be marked during the recess.

(The physical exhibits heretofor marked for identification as Plaintiffs' Exhibits Nos. 6, 7, 8 and 9 were received in evidence.)

By Mr. Huettner:

Q. Mr. Adams, after you started making samples of your neutro cell, what did you do with it?

A. What do you mean, what did I do with it?

Q. Did you try to capitalize on the cell?

A. Yes, I tried to interest the Government in it.

Q. Did you try to interest anybody else, any private concerns?

A. And private concerns, Edison and National Carbon and National Battery Company.

Q. National Battery Company?

A. Yes, sir.

Mr. Huettner: I have just handed the witness four pages, or actually five pages of material, and I would like to have them marked for identification as Plaintiffs' Exhibit No. 10. [fol. 57] Page 1 is a document having a date March 4, 1941. Page 2 is a document entitled "Neutro Cell Characteristics." Page 3 is a graph, the top of which is cut off at the corner, and page 4 is entitled "The Possibilities of the Neutro Cell," and page 5 consists of some handwritten notes which appear on the back of page 4, which the witness has. The witness has the originals.

(Five-page document consisting of a letter of March 4, 1941 from Bert Adams to National Battery Company together with four other sheets consisting respectively of sheets entitled "Neutro Cell Characteristics" "Graph" "The Possibilities of the Neutro Cell" and notes appearing in handwriting on back of page 4, were collectively marked for identification as Plaintiffs' Exhibit No. 10.)

By Mr. Huettner:

Q. Mr. Adams, do you recognize the first page of Plaintiffs Exhibit No. 10?

A. Yes.

Q. What is it?

A. It is a letter I wrote to the National Battery Company with reference to seeing if they had any interest in our kind of battery.

The other papers are the enclosures that I sent with this letter, so that they would have information as to the char- [fol. 58] acteristics and the possibilities of it.

Q. Who made the second page of this document?

A. I did I typed it.

Q. Who made the graph on page 3?

A. I did.

Q. Who typed page 4 entitled "The Possibilities of the Neutro Cell"?

A. I did.

Q. Who made the handwritten notes on the back of page 5?

A. That is my handwriting.

Mr. Huettner: Your Honor, I would like to introduce the five pages marked Plaintiffs' Exhibit No. 10 into evidence as Plaintiffs' Exhibit No. 10.

Mr. Arseneau: I have no objection, Your Honor, but the last sheet here shows some notes. Do you intend to refer to page 6?

Mr. Huettner: I think it appears on the back.

Commissioner Lane: Off the record, Mr. Reporter, please.

(Discussion off the record.)

Commissioner Lane: Back on the record.

Mr. Arseneau: All right.

Commissioner Lane: Plaintiffs' Exhibit No. 10 will be received in evidence.

[fol. 59] (The documents heretofore marked for identification as Plaintiffs' Exhibit No. 10, were received in evidence.)

By Mr. Huettner:

Q. What was the outcome of your letter, Mr. Adams, of March 4, 1941?

A. There was no interest shown.

Q. Did you get a response to this letter?

A. No.

Q. What did you do?

A. On this particular thing? There was no interest. Then I received a letter from the National Battery to go to Cleveland to their test labs, and I went there and Doctor French tested it. First he thought it was crazy, and then he put it on the test bench and checked it, and it was all right, and then I came back to New York with the battery. I did not leave it nor did I leave any information there.

Q. Did you bring any information with you?

A. I brought some information but no information which was vital.

Mr. Huettner: I am handing the witness five pages which I would like to have marked as Plaintiffs' Exhibit No. 11 for identification.

Commissioner Lane: It may be so marked.

[fol. 60] (Five-page document, the first page of which is entitled "Possibilities of the Neutro Cell," the second and third pages entitled "Neutro Cell Characteristics," fourth page entitled "Formula for Computing Capacity by Weight and Surface Exposed," and the fifth sheet showing "Capacity—Linear Potential—Small Weight," marked for identification as Plaintiff's Exhibit No. 11.)

By Mr. Huettner:

Q. Do you recognize these pages, Mr. Adams?

A. Yes, I do. I typed them.

Q. What is the notation on page 4 of this document?

A. (Reading) "This formula copied by F. H. French at Cleveland laboratories exide National Carbon Company on Aug. 22—1941 morning."

Q. Whose writing is that?

A. That is my writing.

Q. What does this indicate to you?

A. It indicates that he had taken down, copied from this page, this information which is above it.

Q. The data on that page, does it disclose the chemical compositions of your neutro cell?

A. It does not.

Q. What does it not disclose?

A. It does not disclose the cuprous chloride or the carbon.

[fol. 61] Q. How did you identify it on page 4?

A. "Element X."

Q. When you went to see Mr. French, did you have these pages with you?

A. Yes.

Q. You said you had something else?

A. Yes, I had characteristics of the linear potential and what possible use I thought at the time could be made of the cell, and a sort of specification.

Q. What was the cell like which you had with you?

A. It was a cell something similar to this (indicating).

Mr. Huettner: The witness is pointing to Plaintiffs' Exhibit No. 4.

By Mr. Huettner:

Q. Who typed all the pages in Plaintiffs' Exhibit No. 11 for identification?

A. These were all typed by me.

Q. Do you recall when they were typed?

A. In 1941.

Mr. Huettner: I offer into evidence the five pages which have been identified as Plaintiffs' Exhibit No. 11 for identification.

Mr. Arseneau: No objection, Your Honor.

Commissioner Lane: Plaintiffs' Exhibit No. 11 will be [fol. 62] received.

(The document heretofore marked for identification Plaintiffs' Exhibit No. 11 was received in evidence.)

By Mr. Huettner:

Q. Did you interest anybody else in your battery, Mr. Adams?

A. Yes, the Government.

Q. Anybody besides the Government?

A. A friend of mine, John Sandhaas, tried to find interest through the Government. I believe he wrote to Washington.

Q. Mr. Adams, I show you a document containing five pages which is already in evidence as Trial Exhibit No. 15, pages 1 to 5.

A. Yes, sir.

Mr. Huettner: I would like first to introduce one more document.

Commissioner Lane: Proceed.

By Mr. Huettner:

Q. Mr. Adams, I show you a document consisting of four pages which I would like to have marked as Plaintiffs' Exhibit No. 12 for identification. Do you recognize these documents?

A. Yes.

[fol. 63] (Document consisting of four pages, the first page of which is a letter dated April 3, 1941 to Thomas A. Edison, Inc., together with letter dated April 17, 1941 from

Thomas A. Edison to Bert Adams, plus two graphs, were collectively marked for identification as Plaintiffs' Exhibit No. 12.)

By Mr. Huettner:

Q. What are these documents?

A. The first one is a letter I wrote to Thomas A. Edison, addressed to Mr. Stamper, in reference to a test cell which I left on March 20, 1941, to see whether they had tested it, or what happened to it.

Q. Did you write the letter on the first page of this document?

A. I wrote the letter.

Q. On what date?

A. On April 3, 1941.

Q. What is page 2 of this document, Plaintiffs' Exhibit No. 12 for identification?

A. Page 2 is a letter from Mr. Patterson, Chief Engineer of Thomas A. Edison, stating that they had failed to return the graphs of voltage and current characteristic curves which I had left with him when I left the battery, or when I took my battery back which they did not test.

Q. Did you receive the letter on page 2 of Plaintiffs' [fol. 64] Exhibit No. 12 for identification?

A. Sir?

Q. Did you receive this letter?

A. Yes, I did, and this is it.

Q. What are pages 3 and 4 of Plaintiffs' Exhibit No. 12 for identification?

A. No. 3 is the original curve I gave Edison, and so is No. 4, of similar proportion.

Q. Did you make the curves shown on pages 3 and 4 of this exhibit?

A. Yes.

Q. Are these the curves referred to in Mr. Patterson's letter?

A. Yes.

Mr. Huettner: I offer into evidence the four pages which the witness has identified as Plaintiffs' Exhibit No. 12.

Commissioner Lane: Any objection?

Mr. Arseneau: No objection.

Commission Lane: Plaintiffs' Exhibit No. 12 is received in evidence.

(The document heretofore marked for identification Plaintiffs' Exhibit No. 12 was received in evidence.)

[fol. 65] By Mr. Huettner:

Q. On your visit to the Edison Company on March 20, 1941, you indicated on page 1 making such a trip, and what did you bring with you, Mr. Adams?

A. One battery.

Q. Anything else?

A. Those curves and the specifications.

Q. Did you leave the battery with them?

A. I did.

Q. Did you ever disclose to them the chemical composition of your battery?

A. No, they did not ask for it and I did not disclose it.

Q. What did they do with this battery at Edison?

A. From the oral information received, they just talked it over and decided that they would not go into that type of battery, and that they were not interested in it at the time.

Q. I now hand you the exhibit which we have had marked, which is Trial Exhibit No. 15, pages 1 to 5, and this letter is stipulated to be a letter from Mr. Sandhaas to Mr. Charles F. Kettering, Chairman of the National Inventors Council, dated January 7, 1942. Why did Mr. Sandhaas write this letter?

[fol. 66] A. To interest the Government in the battery.

Q. Where there any enclosures with this letter?

A. Yes, I had given Mr. Sandhaas the specifications and the possibilities and the curves which he later had typed.

Q. Are those shown on pages 2 and 3 of this exhibit?

A. Right, they are copies of the originals which I gave to Sandhaas.

Q. You gave to Mr. Sandhaas the data contained on pages 2 and 3?

A. Right, and also the curves.

Q. And also the curves?

A. Yes, sir.

Q. And he received this data?

A. Yes, sir.

Q. Did you check this data before it was sent in?

A. Some of it was checked and some of it was not checked. It was too late.

Q. The particular data shown on pages 2 and 3, you mean?

A. Yes, sir.

Q. I show you a copy of a letter which is admitted in evidence as Trial Exhibit No. 17, page 1. Do you recognize this letter, Mr. Adams?

[fol. 67] A. Yes, I do. This is a copy that Sandhaas gave me after he wrote to Captain Shumaker of the Research and Development Division, Navy Department, Washington, D. C.

Q. Why did Mr. Sandhaas write this letter?

A. To interest the Government in this patent.

Q. Were there any enclosures with this letter?

A. Yes.

Q. I direct your attention to the paragraph numbered 2, and will you read it?

A. The usual characteristics and curves were very similar to the ones of previous characteristics and curves of Sandhaas, and they were sent.

Q. Are you talking about the previous exhibit, Trial Exhibit No. 15, pages 2 to 5, the enclosures?

A. Yes, sir, those were sent with it.

Q. I show you a copy of Trial Exhibit No. 15, pages 6 through 11.

A. Yes, sir.

Mr. Huettner: Your Honor, this is a retyped copy from the original. It was almost illegible but it is stipulated to be Trial Exhibit No. 15 and has been admitted as retyped.

Commissioner Lane: All right.

By Mr. Huettner:

Q. What is this letter, Mr. Adams?

[fol. 68] A. It is a letter written by John Sandhaas to the Research & Development Division, Office of the Signal Officer, War Department, Washington, D. C.

Q. Where there any enclosures with this letter?

A. Yes, there were.

Q. Are those enclosures shown on the third, fourth, fifth and sixth and seventh pages of Trial Exhibit No. 15?

A. Yes.

Q. Mr. Adams, did you get any response from the letter which you sent to the Navy, and I refer to Trial Exhibit No. 17, page 8, and particularly to the reference (a)?

A. Yes, the response was that the Bureau wanted more information, and possibly in the form of a patent application, if the patent had been applied for. In other words, they requested more information on it, and the letter was sent by direction of Admiral Blandy.

Q. I hand you a copy of Trial Exhibit No. 17, page 2, and ask you if you recognize this letter?

A. Yes, sir, this is a letter that I used when I came to Washington at the Bureau of Ordnance.

Q. When was this letter prepared by you?

A. January 20, 1942.

Q. Why?

A. To introduce me to Captain Shumaker, Bureau of [fol. 69] Ordnance.

Q. Why did you want to see Captain Shumaker?

A. To speak in the interest of this particular type of battery, the neutro cell.

Q. Mr. Adams, I hand you a copy of Trial Exhibit No. 16, page 1. Do you recognize this document?

A. I do.

Q. What is it, Mr. Adams?

A. It is part of the pages of a book that I kept, with all the expenses incurred.

Q. How did you keep the entries on this book, Mr. Adams?

A. Chronologically.

Q. As they happened?

A. Yes, sir, as they happened.

Q. I refer you to the entry dated January 21, 1942, and would you read that entry?

A. (Reading) "Jan. 21—1942 Trip to Washington from 1-21-42 to 1-24-42 (Navy)."

Q. What does that indicate to you, Mr. Adams?

A. This indicates that I came to Washington during that period, and that is the particular trip for which this letter was written.

Q. You are now talking about Trial Exhibit No. 17, [fol. 70] page 2?

A. Yes, sir.

Q. I now hand you a small piece of paper which appears to be taken out of a spiral notebook, being Trial Exhibit No. 16, page 2. Do you recognize this piece of paper?

A. Yes.

Q. What does that indicate to you?

A. It indicates to me the people I contacted here.

Q. Whom did you contact?

A. Mr. Irlond at the War Department Research & Development, and I remember the Bureau was across the street from the Bureau of Ordnance, and I was referred by Captain McConoughty to Captain Adams in the Signal Corps at Fort Monmouth for test, and at the Signal Corps, further down on the same page, is the name of Mr. Daniels and Captain Adams, who were the first two people I saw, and then Doctor Payne.

Q. The last people you mentioned, where did you see them?

A. At Fort Monmouth.

Q. Instead of in Washington?

A. Yes, sir.

Q. Not in Washington?

A. No.

Q. I hand you a document, Mr. Adams, entitled "Tele- [fol. 71] phone message." Do you recognize this document?

A. I do.

Q. What does it relate to?

A. It relates to a telephone call from Mr. McMurray.

Q. Where was he?

A. At the Dodge Hotel here in Washington.

Q. What is the date of this memorandum?

A. The date is January 22, 1942.

Q. Did you receive this message?

A. Yes.

Q. Did you make the call requested on it?

A. Yes.

Mr. Huettner: I introduce the Telephone Message from the Dodge Hotel, dated January 22, 1942, as Plaintiffs' Exhibit No. 13.

Mr. Arseneau: No objection.

Commissioner Lane: Plaintiffs' Exhibit No. 13 is received.

(Telephone Message from Dodge Hotel dated January 22, 1942 was received in evidence as Plaintiffs' Exhibit No. 13.)

By Mr. Huettner:

Q. Now, Mr. Adams, when you were here in Washington during the period January 21, 1942 to January 24, 1942, you [fol. 72] stated that you met with a Mr. Irland and who else?

A. Captain Shumaker.

Q. Anybody else?

A. I don't recall the other names.

Q. What did you bring with you when you came to Washington on this trip?

A. One battery and a set of curves and a set of characteristics.

Q. Similar to the ones that were furnished to the Navy?

A. Yes, sir.

Q. In other words, more copies?

A. Yes.

Q. What did you disclose to the Government personnel that you talked to while in Washington?

A. I disclosed the entire chemical reaction. I told them everything I knew at the time. I told them the battery could be made of silver and gold chloride.

Q. Where did you disclose this?

A. At the Navy, Bureau of Ordnance, at the conference.

Q. How many people were in that conference?

A. Roughly one dozen, I would say.

Q. To you knowledge, whom did they represent?

A. They represented the Government, the Navy. They were Navy specialized personnel, such as chemists and [fol. 73] electronics people, and the submarine people were there, too.

Q. Did you disclose this to them?

A. Yes, sir, it was necessary, and I disclosed the entire thing so that they could use it in case they needed it for armaments.

Q. What was the outcome of your visit here in Washington in January 1942?

A. I was directed to go to Fort Monmouth, and they

would communicate at the time to tell them that I was coming there with this battery.

Commissioner Lane: Our recess for lunch is due at any time when you come to a good stopping point. Are you jumping from Washington to Fort Monmouth now?

Mr. Huettner: I think this would be a good stopping point.

Commissioner Lane. It is 12:35. Do you want to come back at 2:00 o'clock? Is that long enough?

Mr. Huettner: Very good.

Commissioner Lane: We will recess now until 2:00 o'clock.

(Whereupon, at 12:35 o'clock p.m., a recess was taken until 2:00 o'clock p.m.)

[fol. 74] Afternoon Session (2:00 o'clock p.m.)

Commissioner Lane: Before we start, I have received from Defendant's counsel, in a letter dated today, a certified copy of the contract which was referred to this morning, NObs 20600, with the request that it be received as a Commissioner's exhibit. Do the Plaintiffs have any objection to that?

Mr. Reilly: We would like to have an opportunity to look at the exhibit, if we may, and could I answer tomorrow as to both of the documents?

Commissioner Lane: Yes, sir. Do you have copies of the contract and of Defendant's Answer?

Mr. Reilly: I have probably got some copies, such as they are, and we can try to decipher them today.

Commissioner Lane: Very well.

Mr. Reilly: I might say by looking at this, that sometimes the photostats turn out better.

Commissioner Lane: You may proceed.

WHEREUPON BERT N. ADAMS, the witness on the stand at the taking of the recess, resumed the stand and testified further on behalf of the Plaintiffs, as follows:
[fol. 75] Direct examination (resumed)

By Mr. Huettner:

Q. Mr. Adams, when you were in Washington from January 21, 1942 to January 24, 1942, did you visit any other Government agencies than the Bureau of Ordnance?

A. The Naval Research and the Bureau of Ships.

Q. What did you do when you visited the Bureau of Naval Research and the Bureau of Ships?

A. We discussed the chemical composition of the cells and their possible use to the military.

Q. What cells are you referring to?

A. To the cuprous chloride and magnesium cells.

Q. Is the one before you similar to the one you were demonstrating with the Government, and are you referring to Plaintiffs' Exhibit No. 4?

A. Yes, sir.

Q. What was the outcome of your visit to Washington?

A. I was directed to Fort Monmouth.

Q. Mr. Adams, I show you Trial Exhibit No. 16, page 1, to which you referred earlier, and ask you if there is any entry there which would be helpful with respect to this matter?

A. Yes, on January 21, 1942, it states:

"Trip to Washington from 1-21-42 to 1-24-42 (Navy)."

[fol. 76] Q. What does that indicate to you?

A. It indicates taking a trip to Washington.

Q. To where?

A. To Washington, to the Navy.

Q. Would you read the next entry?

A. The next entry reads:

"January 26—1942 Trip to Ft. Monmouth for Army tests. Left 1 cell."

Q. What does that indicate to you, Mr. Adams?

A. That I went to Fort Monmouth from Washington.

Q. Mr. Adams, I show you Trial Exhibit No. 16, page 3. Do you recognize this document?

A. Yes.

Q. What is it, Mr. Adams?

A. It is a page from a notebook that I had at the time, the name of the director and the places where I went at Fort Monmouth, and who I talked to.

Q. With whom did you talk at Fort Monmouth?

A. Mr. Ellis and Mr. Daniels.

Q. Anybody else?

A. Doctor Payne.

Q. Did you bring anything with you to Fort Monmouth on this trip?

A. One cell.

[fol. 77] Q. Did you bring anything else?

A. A set of curves and the characteristics of the cell, and possible uses.

Q. I show you Trial Exhibit No. 15, pages 1 to 5, which we have already identified, the letter of Sandhaas to Mr. Kettering, which had enclosures. What is that?

A. It is similar to the others.

Q. It is similiar to the others?

A. In fact they were copies.

Q. Is there a cell before you, Mr. Adams, which you took to Fort Monmouth?

A. I didn't take it.

Q. Is there a cell before you which is similar to the one you took to Fort Monmouth?

A. Exactly like it.

Q. You just picked up Plaintiffs' Exhibit No. 4?

A. Yes, sir.

Q. When you brought that to Fort Monmouth, what did they do with it there, Mr. Adams?

A. They were just credulous, and then they tested it, and they asked me how it was made, and I informed them. When they saw how it was made——

Q. Just what did you tell them?

A. I told them cuprous chloride fused or molded or [fol. 78] blended, and they could be made out of silver chloride or gold chloride, and that it had a linear potential, and I explained that I activated it by plain water, and that the anode was magnesium.

Q. Did the representatives at Fort Monmouth do anything to the battery?

A. Yes, they tested it.

Q. Were you present at these tests?

A. At the initial test, yes.

Q. Will you explain what kind of testing they did?

A. They put water in it. They had some distilled water and at first I remember they thought faucet water might contain impurities which might hurt it, and I said, all right, to use the other water. In fact they put in distilled water and they handled it and they had a system where they would press a button and get the voltage reading and the amperage, and they tested it.

Q. What were the results of these tests?

A. It showed a linear potential.

Q. Did the voltage meter show anything?

A. Yes, it showed a potential at the voltage I recommended, but I forget what it was now.

Q. Did you see anyone else on this first trip to Fort Monmouth, other than Doctor Payne, Mr. Daniels and Mr. Ellis?

[fol. 79] A. Yes, I saw Captain Adams, Captain Kingston.

Q. Did you see any other people, on any of your official trips to Fort Monmouth?

A. Yes, on later trips I met Kestler and Bedrosian.

Q. Anybody else?

A. Yes, there were others, Mandell, and I have a hazy idea of others. Those hurriedly are all the names.

Q. Did you ever meet a Mr. Glassner?

A. Yes, sir.

Q. Doctor Fischbach?

A. Yes.

Q. Mr. Adams, I hand you a letter entitled Trial Exhibit No. 12, page 1. Do you recognize this letter, or what it is?

A. It is a copy of the letter written by Captain Clarence Kingston as to the neutro cells, the two cells to be delivered for future tests at their laboratory at Fort Monmouth and that they were to be sent prepaid, without cost to the Government.

Q. I hand you a copy of Trial Exhibit No. 16, page 4. Did you deliver the cells requested by Captain Kingston?

A. Yes, I did.

Q. When did you deliver these cells?

[fol. 80] A. February 2, 1942.

Q. Is there an entry noted there?

A. February 9, 1942. Pardon me, yes, there is an entry "Deliver 2 cells to Lab No. 2." It says "Trip to Fort Monmouth to deliver 2 cells to Lab No. 2."

Q. To whom did you deliver the cells at Fort Monmouth?

A. When I went there, I always delivered them to Doctor Payne or Mr. Daniels, who were together at the time. They always came in twos. They would come in the lobby to escort me in, unless it was at the Eaton Place, where they had a special secret lab, and then you were escorted by girls as a security measure.

Q. Did Doctor Payne or Mr. Ellis tell you why they wanted these two additional cells?

A. For test.

Q. Did they say anything about the test they made on the first cell which you had delivered to them?

A. No.

Q. Did they say anything about your first cell?

A. The only thing was that they found that it heated, or overheated, and I explained to them at the time that it would be advantageous for cold temperatures.

Q. Why would it be advantageous for cold temperatures?

A. Because it would not freeze, and some did heat and [fol. 81] some did not heat, and when they overheated, they were overloaded for the area or the drain for which they were made, and I told them that for Arctic use they could be overloaded to the extent necessary to keep them from freezing up.

Q. Is the heating of a battery an advantage or a disadvantage?

A. In that case it was an advantage.

Q. Mr. Adams, I hand you a copy of Trial Exhibit No. 17, page 3. Do you recognize this letter?

A. Yes.

Q. What is it, Mr. Adams?

A. It is a letter that I wrote following the request of Mr. Ellis and Mr. Daniels, and I wrote to them that I was sending them two positive cathodes, one spent and the other as it came from the mold.

Q. In other words, one was used and one was not used?

A. Yes, sir.

Q. Why would a person want a spent cathode?

A. There might be two reasons; one was spectroscopic analysis in general conditions, and the other might be to determine the state of it afterwards in order to determine quantities of electricity or proportions.

Q. Did you send these two electrodes to Fort Monmouth?

A. I did.

[fol. 82] Q. Did you ever hear anything about them after that?

A. No.

Q. Mr. Adams, I hand you a letter which is Trial Exhibit No. 17, page 5; do you recognize this letter?

A. Yes.

Q. What is it, Mr. Adams?

A. It is a copy of a letter request, a request by Captain Kingston for 20 flashlight size cells for testing at −40 F., and they wanted a quotation for a price f.o.b. Fort Monmouth, cash discount, time of delivery after receipt of formal order and priority required to obtain material by the Government services.

Q. What was your reaction when you received this letter, Mr. Adams?

A. I could not make 20 cells, and I so informed them. I did not have the time or anything else, I told them, to make 20 cells, and I could not deliver 20 cells. It was impossible to make 20 items or to make 25 and have a certain group of tests.

Q. Mr. Adams, I refer you to Trial Exhibit No. 16, page 4, which we referred to earlier, which is a sheet from your ledger book, and ask you what was your next contact with Fort Monmouth?

A. On March 26th.

[fol. 83] Q. Was there one before that?

A. There was one trip to Fort Monmouth before that.

Q. On what date?

A. On March 13th.

Q. What did you do when you went to Fort Monmouth on this date? Do you recall?

A. I told them I could not deliver the 20 cells.

Q. To whom did you tell that?

A. To Payne, Daniels, Kingston, and the whole group there.

Q. I show you a copy of a letter, Mr. Adams, which is Trial Exhibit No. 17, page 6. What is the date of this letter?

A. March 13, 1942.

Q. Do you recognize the letter?

A. Yes.

Q. What does it relate to?

A. This is a letter written by Captain Kingston, and handed to me at that time, in order to repeat the order of ten and to legalize the order for ten for free, that I could deliver.

Q. What did you tell Captain Kingston?

A. That I could deliver the samples for free.

Q. For free?

A. Yes, sir. That was the conversation, to get that many [fol. 84] of the whole.

Q. And you could not make 20 and charge them for them?

A. No.

Q. Which Captain Kingston was requesting?

A. That is correct.

Q. Did you make any batteries in reply to Captain Kingston's letter of March 13, 1942?

A. Yes, I did.

Q. I again refer you to Trial Exhibit No. 16, page 4, which is the log book or ledger book, and ask you when you next went to Fort Monmouth?

A. March 26th.

Q. And that was what year?

A. 1942.

Q. What does the entry state?

A. (Reading) "Trip to Ft. Monmouth Delivery of 10 cells."

Q. What kind of cells were these which you delivered to Fort Monmouth on March 26th?

A. Like No. 6.

Q. They are like Plaintiffs' Exhibit No. 6?

A. Yes, sir.

Q. What kind of cell is that?

A. That is a neutro cell.

[fol. 85] Q. Does it always have that designation?

A. The neutro cell, that is the magnesium anode with cuprous chloride and carbon, and activated by water.

Q. Is that a D cell, according to Army designation?

A. This is a D cell, according to commercial designation, and the Army has a different specification. They do not use a "D" cell.

Q. What people did you see at Fort Monmouth upon your visit there on March 26, 1942?

A. I saw the group which I mentioned before, Doctor Payne, Daniels, Ellis, Kingston, Adams, Kestler and Fischbach.

Q. What did you discuss with these men?

A. We discussed the cell in general, and how it was made, and the theory of it.

Q. Did you ask them how their tests were coming along?

A. I did.

Q. What did they say?

A. They never gave me an answer. They were testing.

Q. Mr. Adams, I hand you a copy of Trial Exhibit No. 15, page 12, being a letter dated March 25, 1942. Do you recognize this letter?

A. Yes.

Q. Did you write this letter?

A. I wrote the longhand copy of this letter and Sandhaas [fol. 86] wrote it on his typewriter. This was his typewriter.

Q. But you wrote the letter?

A. I wrote the letter.

Q. What does this letter relate to, Mr. Adams?

A. The specification of batteries that I had sent on to Fort Monmouth.

Q. To what kind of battery does this relate? Is there one before you there?

A. Yes, this one here (indicating).

Q. That is the specification for Plaintiffs' Exhibit No. 6?

A. Yes, sir. In fact, it will prove out from what is here.

Q. What kind of potential do you have for this battery?

A. 1.6 volts and 1.4 volts, with 250 milliamperes continuous drain.

May I say here that the heat has been specified in this particular characteristic, stating that:

> "Maximum safe drain in milliamperes: 300 (will heat above 300 mill's. drain)."

I recall now that they did want to know at what point it would heat for that specific portion, and it was given here, which is given in other specifications.

Q. Was that within their request?

[fol. 87] A. Yes, sir, it was within their request.

Q. Mr. Adams, I show you copy of Trial Exhibit No. 12, page 2. Do you recognize this letter dated February 7, 1942?

A. Yes, sir, this is a copy of a letter that was received by Mr. Sandhaas, and it refers to a request by the Engineering Staff of the National Inventors Council, who made a preliminary examination of the materials submitted, which were our curves and characteristics, but that they lacked necessary details for evaluation, and they are asking for more details.

Q. Do you know who Mr. Green is?

A. Yes, he is Assistant Chief Engineer of the National Inventors Council.

Q. Mr. Adams, I show you a copy of Trial Exhibit No. 13B; do you recognize this booklet?

A. Yes.

Q. What is it?

A. It is how to proceed when you have an invention with the National Inventors Council, and how to work and produce it.

Q. Did you receive a copy of this booklet?

A. Yes, sir, Mr. Sandhaas did.

Q. Mr. Sandhaas did, and he gave it to you?

A. Yes, sir.

[fol. 88] Q. Mr. Adams, I hand you a copy of Trial Exhibit No. 15, pages 13 through 18, which is a letter from Mr. Sandhaas to the National Inventors Council, dated March 28, 1942. Do you recognize this letter?

A. Yes.

Q. Did you have anything to do with its preparation?

A. Yes, I prepared the original of Sheet 1, Sheet 2, Sheet 4, Sheet 5 and Sheet 6, and Sandhaas had them retyped on his typewriter.

Q. Is there an inaccuracy on the second page?

A. Yes, there is.

Q. Where does that show up, Mr. Adams?

A. Where it says "Positive Plate." First of all, it was

not a plate, and it is a positive cathode or positive electrode. Then further it says "Cuprous carbonate," which it is not.

Q. When you sent this to Mr. Sandhaas, what did you say it was?

A. Cuprous chloride, blended with carbon.

Q. Do you know why this mistake was made?

A. It is a mistake made probably—well, it was a professor in one of our colleges that he knew, and he thought it was a cuprous carbonate. I do not want to mention the man's name.

[fol. 89] Q. Was this letter of Sandhaas, dated March 28, 1942, with the five sheets of enclosure, sent to the National Council?

A. Yes, sir.

Q. I hand you a copy of a letter dated April 8, 1942, addressed to Mr. Sandhaas from J. C. Green. Do you recognize this letter?

A. Yes, it is a copy of the original that Mr. Sandhaas gave me, and I copied it and kept it in my files.

Q. What goes that letter advise you?

A. It states that the National Inventors Council have received this information that Sandhaas mailed to them, and that they will advise us of their findings in a few weeks, and signed by the Chief Engineer J. C. Green.

Q. This letter is Trial Exhibit No. 12, page 8. What does the last sentence of the first paragraph state in relation to Mr. Green's letter dated April 8, 1942?

A. (Reading) "Please accept our thanks for the cooperation shown in making this information available."

Q. The last seatence in the first paragraph states what?

A. (Reading) "You will be advised of their findings within a few weeks."

[fol. 90] Q. I hand you a copy of a retyped letter, dated April 18, 1942, addressed to Mr. John J. Sandhaas from J. C. Green. Do you recognize this letter, Mr. Adams?

A. Yes, this is a copy that I made from the original, which he gave me at the time, and I used it to copy, and gave him back the original.

Q. Who is "he"?

A. Mr. Sandhaas gave me those originals.

Q. What does this letter advise you?

A. It says that they have given the information that we

have mailed to them to the proper authorities, and as soon as their decision becomes available, they will then inform us.

Q. Will you read the last sentence of the first paragraph of this letter?

A. (Reading) "This office will advise you as to their decision as soon as complete information becomes available."

Q. This letter which we have just been referring to is Trial Exhibit No. 12, page 9.

Mr. Adams, were you ever advised by the National Inventors Council as to any results on tests?

A. No, nothing.

Q. Ever?

A. Never.

[fol. 91] Q. Mr. Adams, I hand you a letter which is Trial Exhibit No. 17, page 7, which is dated June 4, 1942, from Mr. J. D. O'Connell, Lieutenant Colonel, Signal Corps, directed to the attention of Mr. Sandhaas. Do you recognize this letter?

A. Yes.

Q. What does this letter relate to, Mr. Adams?

A. That he was advised, Colonel O'Connell was advised from the Chief that the tests were still proceeding, being conducted, and that they would require considerable time for conclusion, and that no results are available at this time, and that we will be informed as soon as they are available. That is the contents of the letter.

Q. Will you read the last sentence of the second paragraph?

A. (Reading) "You will be informed of the results of the Laboratory's tests, promptly upon their conclusion, both as to low temperature and normal temperature applications of the Neutro Cell."

Q. Mr. Adams, did the Department of the Army ever advise you of the results of any tests that they ever made on any of your cells?

A. No, with the exception of the heat.

Q. Was that a formal report, Mr. Adams?

[fol. 92] A. No, only oral.

Q. Did the Army advise you about the operation of your cells at any time?

A. No.

Q. Did they ever say that any of your cells did not work?

A. No.

Q. During this period, Mr. Adams, did you continue experimenting with your neutro cell?

A. I did.

Q. I hand you a document dated New York, May 27, 1942. Is that your signature at the bottom of this document?

A. It is.

Q. Did you type this document?

A. I did.

Q. Who made the drawings?

A. I did.

Q. On or about what date?

A. This was made May 27, 1942.

Q. What does this document relate to, Mr. Adams?

A. It shows a cell, or three cells in parallel, in one single case.

Q. Is this right?

A. Pardon me, no, these were in series. I see it now. [fol. 93] They were in series, in one single case, flat cells.

Q. Is there a cell before you which has the appearance of cells which would be covered by this document?

A. Yes, sir. (Indicating)

Q. You have indicated Plaintiffs' Exhibit No. 8?

A. Yes, sir.

Mr. Huettner: I offer in evidence as Plaintiffs' Exhibit No. 14 the document entitled "Adams Neutro Cell," dated May 27, 1942, and signed by Bert Adams.

Mr. Arseneau: No objection.

Commissioner Lane: It will be received.

(Document entitled "Adams Neutro Cell," consisting of one page, and signed by Bert Adams, heretofore marked for identification as Plaintiffs' Exhibit No. 14 was received in evidence.)

By Mr. Huettner:

Q. Mr. Adams, did you give the information contained in this document to the Government?

A. Yes.

Q. Specifically, to the Army?

A. Yes.

Q. Mr. Adams, I show you a document dated May 16, 1943,

which is signed "Bert Adams." Do you recognize this document?

[fol. 94] A. Yes.

Q. Is that your signature, Mr. Adams?

A. Yes.

Q. Who prepared the document?

A. I did.

Q. On what date?

A. On May 16, 1943.

Q. Why did you prepare this document, Mr. Adams?

A. To show the different potentials and the amount of current between zero time and the time of the volt or point of the maximum drain position for the United States Signal Corps. These were high-temperature cells which I tested before sending the rest of the group to the Signal Corps.

Q. These tests were made for and at the request of the Signal Corps?

A. Yes.

Mr. Huettner: I request that this document be admitted in evidence as Plaintiffs' Exhibit No. 15.

Mr. Arseneau: No objection.

Commissioner Lane: Received.

(One-page document showing graph and showing test of high-temperature cell for U. S. Signal Corps, dated May 16, 1943 was received in evidence as Plaintiffs' Exhibit No. 15.)

[fol. 95] By Mr. Huettner:

Q. Mr. Adams, did you convey the information contained in Plaintiffs' Exhibit No. 15 to the personnel at Fort Monmouth?

A. Yes.

Q. Mr. Adams, I show you a copy of Trial Exhibit No. 16, page 5, and I refer you to the first entry and I ask you if there is in this document any information that you had further contact with Fort Monmouth?

A. Yes, January 11, trip to Fort Monmouth, and I went at the request of the U. S. Signal Corps.

Q. Whom did you see at Fort Monmouth on January 11, 1943?

A. Daniels, Payne, Kingston, Kestler, Fischbach and Ellis.

Q. Did you bring anything with you when you went to Fort Monmouth on this date?

A. Yes.

Q. What did you bring with you?

A. Some batteries, but how many I don't recall.

Q. How do you know you brought some batteries with you?

A. Because I never went without them. I wouldn't take the trip otherwise because I had to take off from work to go [fol. 96] over there, and I was not paid when I didn't work, and so I wouldn't go unless there was a real good reason for going, bringing something, which I could not deliver any other way.

Q. So every time you went to Fort Monmouth, you did that?

A. Yes, sir, plus money out of my own pocket.

Q. What kind of batteries were they, Mr. Adams?

A. Like this (indicating).

Mr. Huettner: The witness just lifted up Plaintiffs' Exhibit No. 5.

The Witness: I brought a few of these square ones. (Indicating)

Mr. Huettner: Indicating Plaintiffs' Exhibit No. 8.

By Mr. Huettner:

Q. When you were at Fort Monmouth on January 11, 1943, did you inquire about the tests that the Government had been conducting on your batteries for almost a year?

A. Yes, sir.

Q. What did you find out?

A. They told me that they were getting heat, and some of them would blow up or evaporate from the sudden heat, and I explained what it was all about, and they were overloaded, and further they said the tests were not conclusive, and they would not give me any answers.

[fol. 97] Q. Did you observe any tests when you went to Fort Monmouth on these various occasions?

A. Sometimes I did, yes. They were on the test board.

Q. Did you ever observe the batteries overheated?

A. No, that I did not.

Q. During these trips to Fort Monmouth, Mr. Adams,

did anybody tell you that your battery had a constant potential?

A. Yes, they conferred with me about that.

Q. Who told you?

A. Both Payne and Daniels.

Mr. Arseneau: I object. I want to make the same objection I made this morning. I think the questions should be couched in a way that would be less leading.

Mr. Huettner: I will try and do better.

By Mr. Huettner:

Q. Mr. Adams, I hand you a copy of Trial Exhibit No. 16, page 6. Is there any indication that you had further contact with Fort Monmouth?

A. Yes, on January 20th, "trip to Fort Monmouth U.S.S.C." That is the United States Signal Corps.

Q. Is there any further identification on this document?

A. Further down, on May 10th it says: "Trip to Fort Monmouth."

[fol. 98] On August 4th, delivery of ten cells.

Mr. Huettner: Your Honor, I neglected to point out that "May," is hard to read because a hole was punched right over it, but I think it is "July 10."

Will Mr. Arseneau go along with the fact that it looks like that?

Mr. Arseneau: All right.

The Witness: May I say something here?

Mr. Huettner: Surely.

The Witness: Here where this has July 10th, a trip to Monmouth, as I recall I did not remember on August 4th the trip to Fort Monmouth, but the ten cells were another trip to Fort Monmouth. It is underneath. I trusted my memory and now it comes back to me. I did not want to write again "Fort Monmouth."

By Mr. Huettner:

Q. You made two trips?

A. Yes.

Q. One on July 10th?

A. Yes.

Q. And one on August 4th?

A. Yes.

Q. Mr. Adams, I hand you a document, Trial Exhibit No. 12, page 5, which is a letter dated March 24, 1943. Do you [fol. 99] recognize this letter?

A. Yes, it is a copy of a letter from Mr. J. C. Green to Sandhaas in relation to finding out what happened to the cell and what interest the Government was taking in it, and would appreciate some information on the present status of the battery.

Q. Do you mean Mr. Green?

A. He asked for this information but didn't receive any, and they were unable to obtain any private expression of interest from the Government agency that the battery was submitted to.

Q. Mr. Adams, I hand you a copy of Trial Exhibit No. 15, page 19, being a letter from Mr. Sandhaas to Mr. Green of the National Inventors Council, dated June 4, 1943. Why did Mr. Sandhaas write this letter?

A. He wrote it in order to see if he could obtain priority for magnesium sheet to make other cells during the war.

Q. Why did you have to go through this routine?

A. Because you could not obtain magnesium without priority, from the War Production Board.

Q. Was it a difficult metal to get?

A. It was impossible without a priority.

Q. To whom would they give priority?

[fol. 100] A. To those who were experimenting in the interest of the war exclusively.

Q. I show you copy of a letter, which is Trial Exhibit No. 12, page 8, a letter from Mr. Green to Mr. Sandhaas, in response to his letter of June 4, 1943.

A. It is a letter from Mr. Green to Sandhaas, asking him to fill out the forms, and he would then take up the matter with the War Production Board, to see if they were agreeable to the release of magnesium.

Q. Did you pursue this, Mr. Adams?

A. I did.

Q. Did you obtain magnesium?

A. I did.

Q. I show you a copy of Trial Exhibit No. 17, pages 10

through 15. Are those the documents which led up to procurement of magnesium during the war?

A. Yes, they are.

Q. I direct your attention to the last page of this document, and request that you read it.

A. (Reading) "The magnesium sheets requested will be used in preparing additional samples for the Signal Corps Laboratories at Fort Monmouth, Red Bank, N. J., and for further development of the battery termed 'Neutro Cell' covered by United States Patent No. 2,322,210 issued June [fol. 101] 22, 1943," by the Department of Commerce.

It has their stamp on it.

Q. Mr. Adams, I show you a document entitled "Instruction Sheet for Testing Adams Neutro Cell," and typed on the bottom is "Bert Adams July 13, 1943."

Do you recognize this document?

A. Yes, I typed it.

Q. You typed this document yourself?

A. Yes.

Q. When did you type this document?

A. July 13, 1943.

Q. What does this document relate to, Mr. Adams?

A. It is an instruction sheet for the use of that particular cell which I was using.

Q. Why did you type this sheet?

A. To give it to the Signal Corps. I did not have much faith in their checking, having checked with the girl, and I felt if I gave them an instruction sheet, they would probably make a better test there.

Q. Did you deliver this sheet to anybody there?

A. Doctor Payne, who was always there every time I went there, and Mr. Daniels.

Q. Where?

[fol. 102] A. Fort Monmouth.

Q. When?

A. At that time.

Q. Mr. Adams, is there a battery in front of you which this instruction sheet relates to?

A. Yes.

Q. Which battery?

A. Some were this type (indicating), and some were this type here (indicating).

Mr. Huettner: The witness is pointing to Plaintiffs' Exhibit No. 4 and Plaintiffs' Exhibit No. 5.

By Mr. Huettner:

Q. What is the difference between these two types, Mr. Adams?

A. The amount of material is the same but there is more water here.

Q. You are pointing now to Plaintiffs' Exhibit No. 5?

A. Yes. So if they did put a load on it, it would keep cooler and it would not have the objection of being heated, and that was the purpose of doing it this way.

Q. Where did you make these batteries, Mr. Adams?

A. In my home.

Q. Where?

A. In my cellar and in a workshop or lab.

[fol. 103] Q. Referring again to Trial Exhibit No. 16, page 6, which is the sheet from your ledger book where it has on the top 1943. You say that you made a trip to Fort Monmouth on July 10th and August 4, 1943?

A. Yes, sir.

Q. Did you bring anything with you on your trip to Fort Monmouth on August 4, 1943?

A. Ten cells for test.

Q. What kind of cells were those which you brought with you?

A. Some of these (indicating), and some of these (indicating), both of them.

Mr. Huettner: The Plaintiff has just pointed to Plaintiffs' Exhibits Nos. 5 and 6.

By Mr. Huettner:

Q. When you delivered the cells on August 4, 1943 for testing, did you inquire about the previous cells which you left?

A. I did.

Q. What response did you get?

A. Nothing. They had not come to any conclusion and most of the time involved was spent between three or four individuals, talking about the possibility of preparing for an answer.

[fol. 104] Q. Mr. Adams, I show you a document dated August 10, 1943, signed by V. F. Payne, Technical Adviser. Do you recognize this document?

A. Yes, I do.

Mr. Huettner: This is Trial Exhibit No. 17, page 9, Your Honor.

By Mr. Huettner:

Q. What does this document indicate to you, Mr. Adams?

A. That on August 10, 1943, it is an excuse, written by the War Department, so that I wouldn't be AWOL from Sperry, since I went over to the Signal Corps, and this was to prove that I was there, and I was not just running around.

Q. Did you ask Doctor Payne to write this?

A. Yes, I did.

Q. Did you discuss anything with Doctor Payne on August 10, 1943?

A. Yes, I discussed the same thing, more observations and proportions, weights, amperages and ratios and the area of batteries, weights and possible chemical reactions.

Q. How about testing?

A. On the testing, that would always go off on a tangent and they would give me something vague about it, and that I would know in due time.

Q. What?

[fol. 105] A. That I would know in due time.

Q. But you never did?

A. I never did.

Q. Mr. Adams, did you continue experimenting with your battery during World War II?

A. I did.

Q. What kind of experimental work did you direct your attention to during this period?

A. I used separators. This has a separator (indicating), and this has a plastic separator (indicating).

Mr. Huettner: The witness is talking about Plaintiffs' Exhibits Nos. 8 and 9.

The Witness: And I found out the ratio or the distinction between cathodes, and I made this vent valve (indicating).

Mr. Huettner: Plaintiff is now pointing to a little knob on the top of Plaintiffs' Exhibit No. 9.

The Witness: For aircraft, and I made some changes in case the aircraft fell in the water.

By Mr. Huettner:

Q. What do you mean by changes?

A. After I saw what they had, if a man falls in the water and he has a dry cell, the thing you pull down goes in a raft, and he got a better one by using this type of cell. (Indicating)

[fol. 106] Mr. Huettner: The witness is still talking about Plaintiffs' Exhibit No. 9.

By Mr. Huettner:

Q. Did you bring these improvements to the attention of the Government?

A. Yes, sir.

Q. I hand you a copy of Trial Exhibit No. 16, page 7. Does this exhibit indicate any further personal contact with the Government at Fort Monmouth?

A. Yes.

Q. When?

A. You can hardly see it but trip to Fort Monmouth.

Q. Did you talk to anybody down there?

A. I talked to Doctor Payne, Mr. Daniels and Doctor Fischbach and Mr. Ellis.

Q. Did you leave anything there when you were down there?

A. Yes, I left this type of cell (indicating).

Mr. Huettner: The witness is pointing to Plaintiffs' Exhibit No. 9. That is the plastic case.

By Mr. Huettner:

Q. When you were down there on June 22, 1948, did you inquire about the tests which were made on all the previous cells that you had submitted to them?

[fol. 107] A. Yes.

Q. What were the results?

A. That they had no answer yet.

Q. Do you know a Mr. De Palma?

A. Yes, I do. He is a friend of mine.

Q. I show you a copy of Trial Exhibit No. 17, page 4. Do you recognize this letter?

A. Yes, this is a copy of a letter that De Palma sent to Doctor Fischbach.

Q. At whose request did Mr. De Palma send this letter?

A. At mine, after we found out that the battery had been copied.

Q. In an article, Mr. Adams?

A. Yes, sir.

Q. I show you a copy of Electrical Engineering, August 1950, pages 100 through 104.

A. This is the article that initiated the sending of that letter.

Q. Who is the author of this article?

A. Adolph Fischbach.

Q. He is the same Fischbach that is mentioned at least in your notes, Trial Exhibit No. 16, page 7, with regard to your visit of June 22, 1948?

A. Yes.

[fol. 108] Q. The same Fischbach?

A. Yes.

Q. How long was he at Fort Monmouth, to your knowledge?

A. I don't know. I couldn't answer that question.

Q. When did you first run across Mr. Fischbach?

A. Earlier than that but I could not specify, and I would not attempt to say the date because I don't know.

Q. Now after you had Mr. De Palma send this letter, which is Trial Exhibit No. 17, page 4, did you or Mr. De Palma ever get a response from Mr. Fischbach?

A. No, we never did.

Mr. Huettner: I would like to introduce into evidence the article about which the witness has testified, which stimulated the writing of Mr. De Palma's letter. It is from Electrical Engineering, and it is entitled "Special Purpose Batteries" by Adolph Fischbach, August 1950, pages 701 to 704 inclusive. It will be Plaintiffs' Exhibit No. 16.

Mr. Arseneau: May I ask a question? There was an in-

struction sheet. I may have missed it. I did not think it was formally offered.

Commissioner Lane: I do not think so.

Mr. Huettner: I would like to introduce as Plaintiffs' Exhibit No. 17 the Instruction Sheet for Testing Adams Neutro Cell, dated July 13, 1943.

[fol. 109] Mr. Arseneau: What number is that?

Mr. Huettner: Plaintiffs' Exhibit No. 17.

Commissioner Lane: It will be received in evidence.

(Sheet entitled Instruction Sheet for Testing Adams Neutro Cell, dated July 13, 1943 was received in evidence as Plaintiffs' Exhibit No. 17.)

Mr. Huettner: Is there any objection to Plaintiffs' Exhibit No. 16?

Mr. Arseneau: Is 16 the Electrical Engineering magazine article?

Mr. Huettner: Yes, sir.

Mr. Arseneau: No objection.

Commissioner Lane: Plaintiffs' Exhibit No. 16 is also received in evidence.

(Pages 701 through 704 inclusive from the August 1950 issue of Electrical Engineering, containing article entitled Special Purpose Batteries, by Adolph Fischbach, received in evidence as Plaintiffs' Exhibit No. 16.)

By Mr. Huettner:

Q. When did you first find out that somebody was——

Commissioner Lane: Do you want to have a ten-minute recess before you proceed?

Mr. Huettner: All right.

(Short recess.)

[fol. 110] Commissioner Lane: You may continue, Mr. Huettner.

By Mr. Huettner:

Q. Mr. Adams, when did you first find out anyone was manufacturing a water-activated magnesium battery?

A. About 1955.

Q. Did you obtain any material relating to these batteries?

A. Yes.

Q. What kind of battery was it?

A. It was a battery made of a sheet of magnesium, which was wrapped around cuprous chloride cathodes.

Q. Did you obtain any written material? First, who was the manufacturer of the battery in question?

A. Burgess.

Q. Did you obtain any written material on it?

A. Yes.

Q. I hand you a brochure from the Burgess Battery Company, and ask you if this is the written material that you obtained about the battery which you were speaking of?

A. Yes.

Mr. Huettner: I would like to introduce in evidence as Plaintiffs' Exhibit No. 18 the Burgess Battery Company brochure and the basic design of Burgess reserve type power units.

[fol. 111] Is there any objection to this exhibit?

Mr. Arseneau: Yes, I do object to it for this reason:

If the exhibit is being placed in evidence as to the facts stated therein, I object, because it is hearsay so far as I am concerned. In other words, if the recitals in these paragraphs are going to be used as evidence as to what Burgess was actually doing in building this, I object. There was no copyright certificate for instance.

Mr. Huettner: Your Honor, I am not relying on any dates in it other than the one testified to by Mr. Adams, that he received this brochure some time in late 1955, and I don't know when it was published. We don't care when it was published. The first time Mr. Adams saw it was in 1955, and he has testified to that.

I would also like to call attention to Paragraph 8 of the stipulation entered into by the parties on June 8, 1961, where it states that publications may be presented into evidence without certification.

I believe that this publication falls within the terms of that paragraph.

Commissioner Lane: As I understand it, this Burgess brochure and data sheet is being offered only as evidence of what Mr. Adams received some time in 1955?

Mr. Huettner: As his first contact, and when he first [fol. 112] learned that water-activated batteries having magnesium in them were being made.

Mr. Arseneau: May it please the Court, if that is the purpose of the offer, I have no objection, namely, if it is offered to show by the article which is introduced that this is what Burgess was publishing then.

Mr. Huettner: That is our purpose. There is no question about that, Your Honor.

Commissioner Lane: Does the Plaintiff intend to rely on this to show what Burgess was doing as distinguished from what Mr. Adams was making?

Mr. Huettner: We will rely upon this to the extent that Burgess published this, and these are what they were doing, yes. We will rely on that. We will not rely upon any date, other than the date when it first came in contact with Mr. Adams.

Commissioner Lane: I am not sure that these documents carry much weight as evidence as to what Burgess was doing. It may be evidence as to what he published, but so far as being anything further than that, I have my doubts.

Mr. Huettner: We agree with that, Your Honor, and under those conditions may this be admitted into evidence as Plaintiffs' Exhibit No. 18?

Commissioner Lane: It is received in evidence.

[fol. 113] (Burgess Battery Company brochure was received in evidence as Plaintiffs' Exhibit No. 18.)

By Mr. Huettner:

Q. Did you receive any publication from any other manufacturers?

A. Yes, sir.

Q. I hand you a copy of a document which is entitled "Engineering Bulletin." Is this the document which you obtained?

A. Yes, sir.

Q. About when, Mr. Adams?

A. About 1955.

Mr. Huettner: I request that this document be introduced in evidence as Plaintiffs' Exhibit No. 19 under the same

conditions as set forth for in the admission of Plaintiffs' Exhibit No. 18.

Mr. Arseneau: I have no objection to either offer as evidentiary with respect to the date when Mr. Adams first learned of the facts stated therein.

Commissioner Lane: Plaintiffs' Exhibit No. 19 will be received in evidence under the conditions that Plaintiffs' counsel stated.

(Five-page document headed "Ray-O-Vac Engineering Bulletin," on characteristics of the magnesium cuprous chloride battery received in evidence as Plaintiffs' Exhibit No. 19.)

[fol. 114] By Mr. Huettner:

Q. Mr. Adams, did you file a claim with the Government?

A. Yes.

Q. Mr. Adams, did you subsequently file this suit along with other persons?

A. Yes, sir.

Mr. Huettner: Your Honor, I have no further questions of Mr. Adams on direct.

COLLOQUY BETWEEN COURT AND COUNSEL

Commissioner Lane: Mr. Arseneau, would it shorten your cross-examination if we recessed until tomorrow?

Mr. Arseneau: I think it would, Your Honor.

Commissioner Lane: Very well, we will recess now until 10:00 o'clock tomorrow morning.

Mr. Arseneau: May I say something on the record before we recess?

Commissioner Lane: Yes, sir.

Mr. Arseneau: This morning I believe Mr. Reilly made reference to Defendant's Answer in response to certain paragraphs in the Discovery Stipulation, and I believe one of the things he referred to was the fact that a lot of letters from contractors, et cetera, were blanked. As I understand the procedure, Defendant is placed under order to furnish printed copies of the letters as blanked, and turn them over to the Court.

[fol. 115] I would like to suggest that I have no objection

to that but rather than there being embodied in the text of the reporter's transcript, I would request that the order be typed out formally designating the material to be turned over, and also, if possible, set forth the basis.

My view is that the material already turned over was done in accordance with the number of paragraphs in the stipulation, and if the letters are going to be inspected when they are turned over to the Plaintiffs' attorney, I would like to have the request on a formal basis.

Mr. Reilly: I am not sure a reply from me is required. We determined this point before, Your Honor will recall, when it was ruled that Mr. Arseneau should bring this material in and turn it over to you, and I think to ask you to sit down and write some order explaining what is to be done is not a proper thing to be asked of you.

I believe they should turn it over to you on the basis of statements made on the record by both counsel here and by yourself, and should do it right now.

Commissioner Lane: May I ask a question, Mr. Arseneau? These documents are not to be turned over to the the Plaintiffs. As I understood Plaintiffs' request, it was for me to receive them, and it is for the Commissioner to decide whether or not the deletions in the fifteen pages should be [fol. 116] viewed by Plaintiffs, and when I go over the complete correspondence and I find a paragraph which I think explains some of the material already in evidence, and should be in, I would suggest that Defendant's counsel put it in.

Plaintiffs' request was merely that the Commissioner go over it and determine whether or not it should be put in.

Mr. Arseneau: I understand that, Your Honor, and the only question I raised was the question about my turning over this material without a formal order on the record.

Mr. Reilly: There is a formal order on the record. It has been required, and that is it. Mr. Arseneau can get a typed copy of it, just as Your Honor will. I have never heard of anything more formal than a Judge's statement on the record, and the reporter has taken it down, Mr. Arseneau.

Mr. Arseneau: All right. Under those circumstances, Your Honor, I will tender to the Court at this time the originals of these letters which we obtained from my office.

(Handing documents to Commissioner)

Commissioner Lane: I will return these to you tomorrow morning, Mr. Arseneau, without Plaintiffs having seen them and I will determine whether Trial Exhibit No. 12 is complete, so far as the issues now are concerned.

We will now take a recess until 10:00 o'clock tomorrow morning.

(Whereupon, at 3:50 o'clock p.m., Monday, July 10, 1961, a recess was taken until 10:00 o'clock a.m., Tuesday, July 11, 1961.)

[fol. 117] **Transcript of Testimony for Plaintiffs (Resumed)—July 11, 1961**

* * * * * * *

[fol. 118] Commissioner Lane: Pursuant to Plaintiffs request made of record yesterday, the Commissioner has now examined the complete originals of the six letters from which parts are in evidence as Trial Exhibit No. 1 herein.

The portion of these letters furnished by Defendant pursuant to the first sentence of Paragraph 15 of the Stipulation filed February 17, 1961, are hereby found to fully comply with Defendant's agreement to furnish copies of portions of letters received from contractors which describe processes of constructing cuprous-chloride batteries for Defendant.

These six letters bear dates within the period November 29, 1960, and February 24, 1961. The portions of these letters not included in Trial Exhibit No. 1 are general comments of the respective authors and/or reference to various contracts.

The originals of these letters are returned to Defendant's counsel at this time.

Are you ready to proceed with the cross-examination of Mr. Adams, or do you have anything further, Mr. Reilly?

Mr. Reilly: I have nothing further except to say that I looked through the material that Mr. Arseneau gave us, and I checked the copies and it seems to me that he wanted this to be marked as a Trial Exhibit and there is no objection at all to any of this material.

I better read them to you. I think the easiest way to [fol. 119] do it is to say that the transmittal letter will be made an exhibit, and I am filing two copies of the Defendant's Answer respecting the sea water torch. It relates to that also, does it not?

Mr. Arseneau: Yes, sir.

Mr. Reilly: You do have an extra copy for us?

OFFERS IN EVIDENCE

Mr. Arseneau: No, but I thought they could be made and then I could offer all at once.

There is one other matter I would like to mention this

morning. With respect to one of the matters handed in yesterday Plaintiffs' counsel mentioned photostating six Burgess blueprints which were to be turned over, and I think the record should show those six blueprints are being turned over this morning. This is the latest material listed there. Since the letter of transmittal which was filed in connection with the stipulation also goes to the Burgess blueprints, I would like to file these with that material.

Mr. Reilly: May I keep this?

Mr. Arseneau: Yes, sir.

Commissioner Lane: I understand that NObs 20600 is Commissioner's Exhibit No. 3.

Mr. Arseneau: Yes, sir.

Commissioner Lane: It will be marked Commissioner's Exhibit No. 3 and received in evidence.

[fol. 120] (Certified copy from the General Accounting Office of Contract NObs 20600 between USA and Thomas A. Edison, Inc., Primary Battery Division, received in evidence as Commissioner's Exhibit No. 3.)

Mr. Reilly: I think we should also mark the folder with the documents concerning the sea water torch.

Mr. Arseneau: I have no objection to that being marked.

Mr. Reilly: I think it should go in.

Commissioner Lane: Are these duplicates?

Mr. Arseneau: Yes, sir, these are duplicates.

Mr. Reilly: That is correct.

Mr. Arseneau: The folder is entitled "Defendant's Further Answer and Response to Paragraphs 12 and 15 of the Stipulation Filed on November 17, 1961."

Commissioner Lane: This folder will be marked Commissioner's Exhibit No. 4 and received in evidence.

(Folder entitled "Defendant's Answer and Response to Paragraphs 12 and 15 of the Stipulation Filed on November 17, 1961," was received in evidence as Commissioner's Exhibit No. 4.)

Commissioner Lane: I do not need two copies. Does anybody want a copy of it?

(No response.)

Commissioner Lane: We will consider the six Burgess blueprints after counsel has had a chance to examine them.

Mr. Reilly: Thank you, Your Honor. Shall we have Mr. [fol. 121] Adams go back on the stand?

Commissioner Lane: Yes, sir.

Mr. Reilly: Take the stand, Mr. Adams.

Whereupon Bert N. Adams, the witness on the stand at the taking of the recess, resumed the stand and testified further on behalf of the Plaintiffs, as follows:

Cross-examination

By Mr. Arseneau:

Q. I believe I would first like to place in the witness' hands a copy of Plaintiffs' Exhibit No. 2. I believe it has not been received as yet, and I am handing him this. I can hand him my copy or the original copy which the reporter has.

(Reporter produces Court copy.)

Q. Mr. Adams, I would like to ask you in connection with Plaintiffs' Exhibit No. 2 what the top-most curve on this configuration indicates, or, in other words, what does the upper-most curve show?

A. It shows the potential curve line. They are both potential lines, and the potential is on the label, where it says "Volts," and it represents the voltage at 1.4 volts at that point.

[fol. 122] Q. I think you have answered my next question. The lowermost curve is also a potential curve, is it not?

A. Yes, sir, with a different voltage. It is in a different form.

Q. Can you tell me how many battery samples were under test at the same time?

A. This was one battery. What I have is a switch, and I can switch off different volts.

Q. I would like now to direct your attention, if I may, to the attached page stapled to the back of the curves, and I

would like to ask you who made the handwritten notations on there in the lower portion of that page?

A. I did.

Q. Can you tell us whether that was made contemporaneously or mode on the same date that the typing was placed on that sheet?

A. It was made on the same date, contemporaneously.

Q. Can you tell the Court this: Can you tell the reason for making a portion of it in typewriting and having a portion of it handwritten?

A. Because this was my copy, and there were other copies and they were sent to people who might be interested, and this tells me it was a summary of this curve. That was the only reason for it.

[fol. 123] Q. I understand. Mr. Adams, if I may, I would like to have the reporter or Mr. Reilly give you a copy of Plaintiffs' Exhibit No. 3, which takes the form of a curve, dated March 13-14, 1941.

Mr. Reilly: You may go ahead with the photostat you have there.

By Mr. Arseneau:

Q. I will give you this copy, Mr. Adams(handing paper to witness).

A. Yes, sir.

Q. Can you tell us in what respect the disclosed material of this graph, where the curves are marked on this paper, differs from the disclosure material in your Patent Application?

A. It does not. Element X, 69 grams is the cuprous chloride, element X1 is .01 grams of carbon, magnesium was 12 grams, and magnesium-chloride was .1 gram, and magnesium-sulphate was .6 grams, and internal support was 15 grams. This was to be the total weight.

Q. At this time are you taking cuprous chloride as Element X and X1 as carbon; Mr. Adams?

A. Yes, sir.

Q. I understand. Mr. Adams, in counsel's opening statement on yesterday a remark was made that the exothermic [fol. 124] reaction that the Signal Corps criticized in connection with your cell was the optimum factor of cuprous

chloride-magnesium cells. Do you have a recollection of that statements?

A. Yes, sir.

Q. Do you adopt that statement as your own?

A. Yes, sir.

Q. Do you agree that it is possible that the cell in certain environments is enhanced by its exothermic character.

A. Yes, sir, and the reason I recall it is that at that time the military people making preliminary efforts to find something to be used in Alaska under the freezing conditions.

Q. I understand. I will now hand you Plaintiffs' Exhibit No. 11, which is a paper entitled "Possibilities of the Neutro Cell," and will turn to page 3—I believe it is page 3 but I do not have it numbered—and I will ask you to read what it says twelve lines up from the bottom.

A. The statement says:

"Does cell heat? No."

I have said that "no." That is only in one reference that the cell does not heat, unless it is overloaded so that the heat is not a natural heat for the cell, but it is a condition that can be brought about if the elements are very close and the drain is greater in that area of the magnesium that it is [fol. 125] supposed to be. That is why that is noted here, because it would not be a normal cell for normal use.

Q. Okay. I think I am clear on that point, sir.

I would like to turn to what I believe is page 4 of the same Plaintiffs' Exhibit and direct your attention to the material typed there under the wording "Capacity."

A. It says:

"2.9 gram element X = 1 ampere hr."

In that sense it will reduce the cuprous and the clear magnesium, equivalent to one ampere hour. That is the procedural arrangement in order to obtain one ampere hour at the voltage of the cell.

Q. Can you tell us the significance of the handwritten notation beneath the typed message?

A. I put down this notation:

"This formula copied by F. H. French at Cleveland laboratories exide National Carbon Co. on August 22, 1941 morning."

Q. Then Mr. French copied the formula accepting the designation of the elements X and X1?

A. Yes, because all he was interested in was the weight factor with relation to the curves.

Q. Does that mean it was submitted to him without know-
[fol. 126] ing what the electrode was constructed of?

A. Yes, sir. I was there and the element X did not say "cuprous chloride."

Q. The next paper which I place in your hands which was identified during the direct examination as Plaintiffs' Exhibit No. 17, which is entitled "Instruction Sheet for Testing Adams Neutro Cell," and I would like first of all to direct your attention to Paragraph 2 of the exhibit.

A. (Reading) "Pour into opening uncovered by wooden stopper to about half inch from top of glass cell jar, either —faucet water—distilled water—or salt water regardless if just salt water with added salt or ocean water. The chemical impurities or sodium chloride do not affect this cell in any way or form. There is no chlorine gas liberated by using salt water."

Q. I notice that you state you can use water regardless if the water just has added salt or is ocean water. Can you tell us the function of salt?

Do you consider sodium chloride to be salt?

A. Yes.

Q. Can you tell us what the function of that would be?

A. It would not do any harm or any good.

Q. In other words, you take the position that the sodium
[fol. 127] chloride added to just tap water would have no effect whatsoever on the operation of the battery?

A. All it can do is serve as a vehicle for the ionization.

Q. I may be repeating myself, but can you tell us again what effect of adding sodium chloride to just plain water would be, in so far as the conductivity of the solution is concerned?

A. The conductivity does not make as much difference after it has settled or reached its potential. The only way that the conductivity could effect it would be if the polarization of the cathode was done in a more rapid form but it can't be done any more rapidly than the chlorine is used, with a hydrogen ion. It can only come about as the hydrogen goes up.

Q. Let me ask the question differently. If you do have simply distilled water in the cell, and you then go ahead and add some salt, as you mentioned, "regardless if just water with added salt or ocean water," what effect does the sodium chloride have on the water electrolyte or the water fluid?

A. It maintains the ionization.

Q. Then it would not matter with respect to the conductivity?

A. It would not matter. I can illustrate it on the blackboard in answer to your question.

Mr. Reilly: Your Honor, I will stipulate that the addition [fol. 128] of sodium chloride to the water hastens the activation of the cell.

Mr. Arseneau: My next question was, what it did to the electrolyte itself with pure water.

Mr. Reilly: It increases conductivity, as I understand it.

Mr. Arseneau: Thank you very much.

By Mr. Arseneau:

Q. Mr. Adams, I would like to ask you something, speaking in terms of the Adams Patent No. 2,322,210, and directing your attention——

Mr. Huettner: Your Honor, I object to any discussion of the patent to which counsel is referring. In our preparation for Mr. Adams' testimony, because of his health, we limited our scope of his examination deliberately, and nowhere in the direct examination was there ever one mention of the patent number whatsoever, and I submit that any questions by counsel for the Defendant relating to the patent would go far beyond the scope of the direct examination and should not be addmitted.

We have a witness here who will discuss the patent in suit. Mr. Adams is not a patent expert.

Mr. Arseneau: Your Honor, supposing we take the position of Plaintiffs, that anything based on this patent exceeds [fol. 129] the scope of the direct examination, still I would like to point out that the patent specification as such purports to describe and protect Mr. Adams' invention. The question about to be propounded does not relate to patent claims but to the description of the material, and since the patent is in suit, I really believe that the question, at least

on the running text of the descriptive material, would be relevant and be in order.

Commissioner Lane: I believe that is proper on cross-examination, but I will sustain the objection to any questions which might ask about any of the claims in the patent.

Mr. Arseneau: I agree with that, Your Honor.

By Mr. Arseneau:

Q. Mr. Adams, I would like to direct your attention to Column 2, perhaps the first paragraph in Column 2.

Mr. Reilly: What is the number of the exhibit?

Mr. Arseneau: I put it in at one time or another as a trial exhibit.

Mr. Reilly: I think it is Trial Exhibit No. 10.

The Witness: Do you want me to read this?

By Mr. Arseneau:

Q. Just read over the lead paragraph in Column 2.

A. (Reading) "After filling with water," and so forth?

Q. Yes.

[fol. 130] A. (Reading.. "After filling with water, the battery is ready for use within thirty minutes."

Do you want me to go further?

Q. Would you, please?

A. (Continuing reading) "However, the battery may be made ready for instant use by supply the container with one gram of chloride of magnesium in the form of a fused drop."

Q. The only question I intend to ask in connection with your patent disclosure is this:

Can you tell us the function of the magnesium chloride or what the reason for dropping it into the distilled water is?

A. It is to avoid that part of the upper swing of the curve in relation to it. It is to tighten it rather than broaden it, because you have the beginning of the potential curve to reach the optimum voltage, and it is to do away with the curve.

Q. Is it the use of the magnesium chloride on the fluid itself which bridges the electrode?

A. The magnesium chloride would hasten the emission of the hydrogen ion from the magnesium plate.

Q. Now another question that I would like to ask you is this, if I may:

[fol. 131] Yesterday during your direct examination I think you mentioned that you tried various chlorides, you tried silver chloride and gold chloride, and I believe at one time you said you tried cupric chloride.

A. Yes, sir.

Q. Can you tell us in what form you tried cupric chloride?

A. The cupric chloride came in a crystalline form, and I blended it, sometimes with water and sometimes fused it.

Q. What do you mean by saying "blended it with water"?

A. Mixed it with water, put it in a test tube and pulverized it and mixed it.

Q. What did you do next?

A. Pasted it with cuprous chloride.

Q. What did you do with the paste?

A. Put it on the screen, in other words I placed it in other ways besides one way. There are many ways of blending the two together.

Q. Did you try it by itself, broken down into a paste, with the use of water?

A. Yes, sir.

Q. What did you do with the electrode made in that fashion?

[fol. 132] A. I tried it or tested it.

Q. Can you tell us something about that?

A. You get a voltage but no amperage. You get a voltage from these two dissimilar metals, regardless of what they are, when you dip them in water.

Q. Can you tell us from your studies in connection with the cupric chloride type of electrode whether you thought you had sufficient?

A. Definitely yes.

Q. For a long period?

A. It would not serve indefinitely or it would not serve for a long period.

Q. Did you have occasion during this portion of the test to ascertain what the solubility of cupric chloride was?

A. No.

Q. I would like to ask you this question also: When you were investigating chlorides, particularly cuprous chloride,

I would like to ask in what form, other than fused, you used cuprous chloride?

A. In water——

Mr. Huettner: Your Honor, I would consider that counsel is using a word which has not been used by the witness.

Mr. Arseneau: May I ask what the word is?

Mr. Huettner: You used the word "fused." If you would [fol. 133] define "fused," so that the witness understands what you are talking about, then the question is perfectly all right.

Mr. Arseneau: My recollection is that during the direct examination Mr. Adams referred to working at various addresses and stated that in his basement he prepared samples which were submitted to various people, and some of the letters relative to those samples that have been offered by Mr. Adams were samples where he had talked about to some extent his fused samples.

Mr. Huettner: If you are using the word "fused" the way Mr. Adams used it, then I have no objection. But if used in any other way, you should define it.

Mr. Arseneau: My impression is that he stated yesterday that the powder was reduced to a molten condition and then poured into some sort of receptacle and allowed to liquefy.

I am asking the witness whether in working with cuprous chloride he constructed other types of electrodes or constructed any electrodes which might have been different than that.

The Witness: Yes, I did, but it was not as convenient as blending with heat. It was the most convenient method I had to use the molds, which were easy to make.

By Mr. Arseneau:

Q. Can you tell us what the other methods were?

[fol. 134] A. I could blend it with water. Of course, you have no reduction without the other metal anyway, so that you put it in water. That was known.

Mr. Reilly: Maybe we could take a brief recess, Your Honor.

Mr. Arseneau: I have just one more question.

Mr. Reilly made it quite clear on the record that Mr.

Adams' health is such as to preclude an extended oral examination, and we will try to bear that in mind. I would like to ask one last question before the recess.

Commissioner Lane: Very well.

By Mr. Arseneau:

Q. Yesterday there was testimony about visits to Fort Monmouth, visits to Washington, to talk to Naval personnel, and I would like to ask Mr. Adams whether in his interviews with Government people at the Navy or Fort Monmouth he ever ascertained as a fact that any of the persons dealt with had authority to bind the United States?

Mr. Huettner: Your Honor, I object to the question unless we know what he means by "binding the United States." I have no idea what that is.

Mr. Arseneau: I have no objection to answering that, Mr. Huettner.

Mr. Huettner: Just a minute, if you please. Your Honor, [fol. 135] I think before the witness is required to answer this question, we would like to have the attorney for the Defendant fulfill the requirements of Paragraph 9 of the stipulation dated February 14, 1961.

He was required to furnish us with information regarding Government personnel who met with Mr. Adams, or any representative of Mr. Adams, during the period from December 1, 1941 to March 7, 1957, who might have had actual authority to act on behalf of the Government. We have requested that the Government furnish us with this information, and they have not furnished it to us, and now they are questioning Mr. Adams about exactly the same thing, and if they want to give it to us, all right, but if they won't give it to us, we certainly do not expect Mr. Adams to give it to them.

Commissioner Lane: It seems to me that the question could be simpler than that, and merely ask the witness whether or not he made any investigation to find out whether the people he talked to had authority to bind the Government. He either did or did not do it. I think he can answer yes or no.

Mr. Arseneau: That kind of answer would be perfectly satisfactory, Your Honor.

Commissioner Lane: I will overrule the objection to the question. Do you understand the question?

[fol. 136] The Witness: May I have it repeated, please?

(Question read.)

The Witness: I assumed they had authority. I could not ascertain it because I had nothing to do with it.

Mr. Arseneau: I think that concludes the cross-examination, Your Honor.

Commissioner Lane: Very well. Do you want a recess before redirect?

Mr. Huettner: Yes, Your Honor, if we may.

(Short recess.)

Commissioner Lane: You may proceed.

Mr. Huettner: Your Honor, I have just one question on redirect.

Commissioner Lane: Very well.

Redirect examination.

By Mr. Huettner:

Q. Mr. Adams, when you have used the term "fused" in your testimony, do you mean only blended or liquefied by heat?

A. I mean blended either by heat or water or with electrical resins. It is a generic term, and blending was the most convenient way at the time.

Mr. Huettner: That is all.

Commissioner Lane: Any further questions, Mr. Arseneau?

[fol. 137] Mr. Arseneau: Only with respect to an objection. I do not think Mr. Adams was asked what other conception or technique he regards as fusing. I think he was asked whether he would regard this as "fusing," but I am willing to let it go for what it is worth.

Commissioner Lane: You may step down, Mr. Adams.

(Witness excused.)

Mr. Reilly: Your Honor, could I have thirty seconds before putting on the next witness?

Commissioner Lane: Yes, sir.

(Pause in the proceedings.)

Mr. Reilly: My next witness will be Mrs. Adams, and she will be back in a moment.

Commissioner Lane: Very well.

Mr. Reilly: Your Honor, while we are waiting, I would like to say on the record for Mr. Arseneau's benefit that Mr. Adams is an extremely sick man, and he has been for I guess ten or fifteen years taking digitalis and mercury material for diabetes, and he has been taking tranquilizers while he has been giving his testimony, and I only say this because I transmitted this information generally to Mr. Arseneau and indicated that we would appreciate him taking that into consideration because we put Mr. Adams on the stand with great reluctance, and I would like to [fol. 138] express my gratitude for the way in which he handled Mr. Adams during cross-examination. It was a very difficult situation so far as all of us are concerned.

I call Mrs. Adams.

Whereupon EMMA ADAMS, a witness produced on behalf of the Plaintiffs, being first duly sworn by said Commissioner, was examined and testified as follows:

Direct examination.

By Mr. Reilly:

Q. Mrs. Adams, will you please state your name and address?

A. Emma Adams, 6 East Street, Hicksville, Long Island, New York.

Q. Are you one of the Plaintiffs in this suit?

A. Yes.

Q. Are you the wife of the Plaintiff, Bert N. Adams?

A. Yes.

Q. Are you a United States citizen?

A. Yes.

Q. When did you marry Mr. Adams?

A. On May 3, 1933.

Q. Where did Mr. Adams work in 1939?

[fol. 139] A. At the World's Fair in New York.

Q. Where did he work in 1940?

A. At the World's Fair in New York, Flushing.

Q. Was that in the summer time?

A. Yes.

Q. Whom did he work for at the World's Fair?

A. For the Breda Company.

Q. Did anything happen to Mr. Adams between 1939 and 1940?

A. Yes, in the early part of 1940 he had a severe heart attack and was taken to the hospital.

Q. Do you recall the date that he came out of the hospital?

A. Yes, he came out May 2nd, the day before our anniversary in 1940.

Q. You remember it, Mrs. Adams, because it was the day before your anniversary, is that correct?

A. Yes, sir.

Q. Did the conditions under which you were living at that time have anything to do with Mr. Adams' health, as you understood it?

A. Yes, the apartment was very cold, and he was getting cold, and it affected his health.

Q. What did you decide to do about the situation?

[fol. 140] A. I decided to move to another apartment.

Q. When did you move?

A. We moved right after he came out of the hospital, May 2nd, the day before our wedding anniversary, and we moved on June 1, 1940.

Q. Where was the apartment?

A. On 112th Avenue, near Springfield Boulevard in Queens Village, Long Island, New York.

Q. From whom did you rent this apartment?

A. Mr. Shulens.

Q. Will you spell his name?

A. S-h-u-l-e-n-s.

Q. How long did you live there, Mrs. Adams?

A. We lived there from June 1st until after Thanksgiving Day.

Q. Did you move out at that time?

A. Yes.

Q. Where did you move then?

A. To a house in Queens Village.

Q. Did you observe Mr. Adams doing anything while you were living at the Shulens?

A. Yes, I saw him studying books on batteries and he was making batteries and experimenting with them.

Q. Did you ever assist him?

[fol. 141] A. Yes, I did.

Q. Would you tell what your assistance consisted of?

A. I would take a record of the meters, and I would put water in the batteries.

Q. Did you observe how he made the batteries?

A. Yes, sir, I did.

Q. Can you tell me about the materials that he took or how he used them?

A. Yes, he used a green powder and he melted it on the kitchen stove.

Q. What color was it after it was melted?

A. It was black.

Q. It was green before melting and black afterwards?

A. Yes, sir.

Q. How did the powder come?

A. Pardon me?

Q. How did the powder come?

A. It would come in containers, and they would be labeled "Cuprous chloride."

Q. Did you notice anything else when Mr. Adams was doing this?

A. Yes, when he poured it it was black and the smell of it was very repugnant, and many times I had to move away.

Q. What did Mr. Adams do with his melted material?

[fol. 142] A. He would pour it in molds that he made.

Q. What did the material look like after it came out of this mold?

A. It would be shaped like a pencil, with a small piece of wire on top of it.

Q. What did he do with this pencil-shaped article?

A. He would take one of them and put it in a glass jar.

Q. Did he put anything else in that jar?

A. Yes, he put a piece of gray metal.

Q. Was there any wire on the gray metal?

A. Yes, he put it in the jar, the gray metal, and two

pieces of wire were sticking out, and one was fastened to the gray metal.

Q. Do you know where the gray metal came from?

A. Yes, the Dow Chemical Company.

Q. How do you know that?

A. He would have it delivered at home, and I would sign the receipt, and that is how the receipt read.

Q. Did you observe Mr. Adams doing anything else to these jars, other than the two pieces of material that he put in the jar, which you have already mentioned?

A. Yes, he would pour water in then.

Q. You have already testified that you did it yourself [fol. 143] sometimes?

A. Yes, sir.

Q. You have also testified that you took readings from meters?

A. Yes, sir.

Q. Would you explain how you took the readings and what information you recorded?

A. He would have the battery attached to a volt meter, and in one column he would put down the time, and in another column he would put down the volts that I read from the dial of the meter.

Q. While this was going on, Mrs. Adams, did anything occur that made Mr. Adams excited?

A. Yes, it was in hot weather—I would say around August—and he was very excited, and I was in the next room, and he called in and he said that he found something that would work very well and would make the batteries work very well.

Q. Did he say what it was?

A. Yes, he said that the cigarette ash was the carbon that he added to it.

Q. Did Mr. Adams make many of these types of batteries while you were at the Shulens?

A. Yes, he did.

[fol. 144] Q. Do you remember Mr. Adams making any others tests on these batteries, other than the one with the meter?

A. Yes, I do. He would take them at night to our bedroom and have them on our dresser, and he would watch them from time to time.

Q. Did these batteries have any kind of an indicator on them which was working?

A. Yes, he had a flashlight bulb on every one of them.

Q. How many were there in the bedroom?

A. There were around seven or eight, and the light was on, and I am a light sleeper, and that bothered me, and he would get out of bed and check them, and every once in a while he would jump out of bed very suddenly, and I wouldn't get too much sleep that night.

Q. Did Mr. Adams make batteries after that date?

A. Yes, he did. He made many more. He worked very hard.

Q. Did you observe that those were tested, too?

A. Yes.

Mr. Reilly: Thank you, Mrs. Adams. That is all I have, Mr. Arsenau.

Mr. Arseneau: I don't believe we have any cross-examination, Your Honor.

Commissioner Lane: Very well. You may step down, Mrs. [fol. 145] Adams.

(Witness excused.)

Mr. Reilly: Thank you, Mrs. Adams.

Will you excuse me once more for fifteen or so seconds, Your Honor? I do apologize.

Commissioner Lane: All right.

(Pause in the proceedings.)

Mr. Reilly: Doctor Mantell, Your Honor, will be our next witness.

Commissioner Lane: Very well.

Mr. Reilly: Your Honor, I would like to say that in brief moment I took, I spoke to Mr. Arseneau and told him that Mr. Adams was going back to New York.

Commissioner Lane: Very well.

Whereupon CHARLES L. MANTELL, a witness produced on behalf of the Plaintiffs, being first duly sworn by said Commissioner, was examined and testified as follows:

Direct examination.

By Mr. Reilly:

Q. Will you state your name and address, please?

A. Charles L. Mantell, 447 Ryder Road, Manhasset, New York.

[fol. 146] Q. Do you have a place of business, Doctor?

A. Yes.

Q. Would you give us that address?

A. I have offices and laboratories at 457 Washington Street, New York 13.

Q. What is your business, sir?

A. I am a consulting chemical engineer.

Q. Doctor, would you state your professional background chronologically, or in whatever other form is convenient for you?

A. I received my Doctorate in Chemical Engineering, the Ph.D. in Chemical Engineering, at Columbia University in 1928. Before that period I had some undergraduate training and had industrial experience with the Aluminum Company of America, and from 1922 to 1937 I was Professor of Chemical Engineering at the School of Science and Technology at Pratt Institute in Brooklyn.

At that time I left the Institute to give attention to consulting practice, and did so until 1948, when I became Chairman of the Department of Chemical Engineering and Professor of Chemical Engineering at Newark College of Engineering, which is the state engineering school of the State of New Jersey, and I currently still hold that position.

Q. Doctor, under whom did you work on your Ph.D. [fol. 147] paper at Columbia?

A. Under Professor Fink, who was Chairman of the Division of Electrochemistry, and I was his first graduate student.

Q. Doctor, you mentioned that you were in the consulting business. Would you indicate to us some of the clients

and firms for which you have done this, that is, for whom your consulting activity has taken place?

A. Among the activities were activities in the electrochemical and electrometallurgical field. Particular examples are the Electromagnesium Corporation and its successor, the Foote Mineral Company, for whom I have been consultant since 1939, and continue to do so.

Another is the American Metal Company, who are one of the large metal refiners in the United States.

I have been responsible for the design and the erection of a number of metallurgical plants in the United States and abroad, the two latest of these being Metales in Bogota, Columbia, which is an electrolytic zinc plant, and Estonifera of Brazil, which is an electrolytic tin plant.

I have designed and been responsible for electrolytic manganese dioxide plants for the Battery Division of Olin Industries.

Q. Doctor, what writing have you done?

[fol. 148] A. My writings have consisted either of technical papers, over one hundred, before Societies, or monographs which are books in the American Chemical Society series. I am responsible for one on tin and co-author of one on calcium, and also the author of Industrial Electrochemistry in the Chemical Industrial Series of McGraw-Hill and this is now in its fourth edition, 1960, under the title of "Electrochemical Engineering."

Q. You have written books on other subjects, have you not, Doctor?

A. Yes, sir, and I have been responsible for several editions of the volume on Absorption in the Chemical Engineering Series and on natural resins, as a result of some fifteen years' association with the Netherland East Indies Government.

Q. Doctor, you are a member of various professional associations?

A. Yes, I am a Member of the American Institute of Chemical Engineers, American Institute of Mining and Metallurgical Engineers, the American Chemical Society, Electrochemical Society, and the American Society of Metals, and others.

Mr. Reilly: Mr. Arseneau, I might say that I have avail-

able a copy of Doctor Mantell's book, if you would like to see it.

[fol. 149] Mr. Arseneau: We will waive that.

By Mr. Reilly:

Q. Doctor, are you the patentee of any United States patents?

A. Yes, I have a number of patents issued in my name. They are all assigned to specific clients for whom the work was done.

Q. What is the general subject matter of these patents?

A. The general subject matter is electrochemical products.

Q. About what is the number?

A. Something of the order of 35 or 40.

Q. Doctor, would you give the Court a brief resume of your experience in testifying in patent cases, where the subject matter is of the nature of the one in suit here?

A. I have testified in a number of patent cases involving electroplating machinery, electroplating processes, specifically electrolytic gold leaf and the like, electrostatic processes and electrostatic painting, and much of the other cases have been in resin technique, the alkyd resins.

Q. Doctor, when did you start testifying as an expert in patent cases?

A. About 1932.

Q. Since that time, approximately how many cases have [fol. 150] you been an expert in?

A. I really can't tell you, without counting them up, but of the order of fifteen or twenty.

Q. Are you an employee of any Plaintiff herein?

A. No.

Q. Are you related to any Plaintiff herein?

A. No.

Q. Are you related to any attorney herein?

A. No.

Q. Are you an employee of any attorney here?

A. Of Kenyon & Kenyon for this case.

Q. Doctor, you mean you have been retained by the firm of Kenyon & Kenyon?

A. Yes, sir.

Q. Have you any interest in the patent in suit?

A. None at all.

Q. Doctor, have you studied the patent in suit filed in this case?

A. Yes, sir.

Q. Doctor, referring to the objects of the invention, column 1, lines 2 to 14, would you summarize this for the Court, please?

A. The words of the patent beginning at line 2 state:

> "An object of my invention is to provide a novel [fol. 151] battery characterized by linear potential and capacity, . . ."

I would like you to remember that the word "linear" here is not a straight-line function as in the mathematical use of the word, but I find the specific use by Adams of "linear" means constant or level.

Q. Do you mean, Doctor, that it is not only linear but it is also parallel to the base of the graph?

A. That is the interpretation that is put on the word by the patentee.

Q. How does the art or the technology refer to the potential of these batteries today?

A. The interesting thing is that many of the technicians use terminology in connection with these batteries in the same way, and they are using the same word in the same sense.

Q. Do you mean "linear"?

A. I mean "linear."

Q. They mean level?

A. They mean level or constant.

Q. Continue, Doctor.

A. (Continuing reading from second paragraph of column 1, page 1 of the patent)

> ". . . wherein the battery is so designed as to eliminate [fol. 152] acids such a sare employed in conventional storage batteries, and in which the battery is of such a nature as to eliminate the release of dangerous fumes."

When it refers to eliminating acids such as employed in conventional storage batteries, that is a reference which

may be interpreted as being an avoidance of sulphuric acid in connection with the electrolyte in lead storage batteries.

The next paragraph states:

> "Another object is to provide a battery which is relatively light in weight with respect to capacity and in which the battery may be manufactured and distributed to the trade in a dry condition and rendered serviceable by merely filling the container with water."

In other words, that is a battery assembled without liquid, or that portion that is conventionally thought of as the electrolyte.

Q. Doctor, just go down through there without re-reading it and itemize those particular objects as they appear. You mentioned the first one as "linear potential"?

A. Linear potential.

Q. What is the second one?

A. The second one is linear capacity, eliminiation of [fol. 153] acidity, light in weight, dry in the sense that no liquids are contained, and made serviceable by the addition of water. In other words, this is a water-activated battery.

Q. Doctor, just explain briefly what "linear potential" does mean.

A. "Linear potential" in the sense of the usage in this patent means that as the battery is activated, the voltage starts from a point at zero and rises and reaches a level, after which it remains constant during the service life of the battery, and then drops off. This constant or linear action means the portion of the curve which is almost at right angles to the vertical or left-hand ordinate and parallel to the bottom ordinate.

Q. What is the significance of "capacity"?

A. This is a similar type of curve for the capacity.

Q. "Potential" is commonly measured in volts?

A. Potential is commonly measured in volts and capacity in amperage or ampere seconds.

Q. Doctor, with reference to this characterization of "linear potential" and "capacity," does that mean under continuous—I don't know how to characterize it—"low-load," "ordinary load," for what might be considered to be the size or weight of the battery if made for ordinary load or average load?

[fol. 154] A. It would exist at medium loads, high loads and low loads.

Q. What happens to this battery, Doctor, if we take a load, which I will not define, but say it is the ordinary load for the battery, which will not heat up, and you increase the load by four or five times? What would happen to the total output of the battery?

A. The total output of the battery, meaning the total ampere hours per second, times the voltage, would be the same irrespective of the manner in which it was discharged. It means that the battery, if it were to be discharged at a very high load, would rise a small number of minutes. If it were to be discharged at a low load, it would rise a less number of minutes, but the potential of the time to the volts, the amperes or the watt seconds, would be approximately the same.

Q. Do you mean the area under the curves would be approximately equal for the two types of discharge?

A. Yes, sir.

Q. There is some falling off of the efficiency when the discharge is fast, is there not?

A. There is.

Q. What is the order of the falling off in efficiency?

A. When your discharge is fast, it is difficult to say, [fol. 155] without all the factors of the design of the battery.

Q. I am reaching too far before defining our terms.

Doctor, you said the battery was light in weight?

A. Yes.

Q. I call your attention to the statement that the battery is light in weight with respect to capacity. Is that correct?

A. That is correct.

Q. Doctor, would you just refer to page 2 of the patent, column 1, lines 7 to 16, and indicate to me briefly what you find to be the additional qualities of the battery which have not been mentioned previously?

A. What page it it?

Q. Page 2, column 1, lines 7 to 16.

A. This is another statement of the relative weight to capacity, that it is light in reference to capacity. It is characterized by linear potential "and will operate successfully under all temperature conditions."

Meaning that it will operate at room temperature, at temperatures above room temperature and and at temperatures below freezing.

Q. How far below, Doctor?

A. Personally, I have tested some of the batteries at −40C, which is the same as −40° Fahrenheit.

[fol. 156] How long it would be would only be a guess on my part, that is as to how low it would go, but I would not be surprised if it went down to −60° Centigrade, and probably could be designed for lower temperatures, if you related the discharge capacity to give you exothermic reactions to overcome the cooling effects at lower temperatures.

Q. Are you saying, Doctor, that this battery can be designed, depending on what you connect it to in the way of a load, to have or not have an exothermic reaction?

A. Yes, sir.

Q. How do you design it not to have an exothermic reaction?

A. The design is not very much different. It is the rate at which you discharge the battery. Discharging at a low rate, you can do so for a long time outhout excessive rise in temperature.

Q. If you connect it to a large load in comparison to the size of the battery, you can heat it up?

A. Yes, sir.

Q. You can choose your conditions so that you can design for different temperature operating conditions in that manner?

A. This is common with the design of all batteries.

Q. And it is common with the design of this battery?

[fol. 157] A. It is common with the design of this battery.

Q. Go ahead, Doctor.

A. It can be manufactured at relatively low cost.

Q. That means cheap?

A. Yes, sir, and discarded when exhausted. There are no dangerous fumes.

Q. What does it mean when it says "and is discarded when exhausted"? That means that once you activate it, you have got to run it all the way through?

A. Yes, sir.

Q. Is that an advantage?

A. It is a disadvantage for certain operations for which

the battery was not intended, such as bell ringing. It is not a disadvantage but a definite advantage where you want an appreciable amount over a period of time or over a period of short time.

Q. Do you mean continuous power?

A. Continuous power.

Q. Is that good?

A. You have certain applications where it is highly advantageous.

Q. Doctor, you said this battery will give you a level potential and a level amperage. Is there a particular use in power equipment for which that feature is advantageous? [fol. 158] A. Yes, for example if you wanted some sort of signalling system, or a radio system, or an amplifying system, you would like to have a mechanism which will give you the same voltage and the same power until the point of failure.

Q. Why it that?

A. Because it allows the operation of the apparatus which is being supplied with power in connection with the battery.

Q. I understand. Are you talking about the filament of the radio tube?

A. That would be a typical example of your power-consuming thing.

Q. Why do you want to maintain a constant volume or constant amperage to a radio tube?

A. If you do not have a constant voltage or a constant bias, your transmitting mechanism will fade and not allow continuity of operation.

Q. Doctor, are there any other uses which come to your mind where short-time continuous heavy power, which you have indicated, can be obtained from these batteries and which might be important?

A. Yes, in typical overseas flight some of our planes provide the passengers with life jackets, and all the life jackets [fol. 159] have little signal lamps, signal lights of the type which you want to operate when once started, and they continue to operate as a mechanism of rescue aid.

Q. Fall in the water and the light goes on?

A. Fall in the water and light goes on, and you want the light to continue without failure.

Q. Is this what you are talking about? (Indicating)

A. I am talking about the little battery here which is connected to a light, and that activates the battery, and when it exposes the battery to sea water, that causes the battery to be the source of power of this light, and that light continues until the battery is exhausted, so far as other components are concerned, and these may be designed for a day or longer, or they may be designed for a shorter time, depending on the particular eventuality provided against.

Q. Doctor, if you did not have this switch on here, and somebody fell into the water, or was in the water, and this battery was left open to the water, would it automatically light?

A. It would automatically light. What this switch does is disengage the bottom section of the battery to open the content of that sea water mechanism.

Q. Do you think something like that would have been a pretty handy thing to have had during World War II?

[fol. 160] A. Yes, sir.

Q. Thank you, Doctor.

I suppose I better identify this. It is Plaintiffs' Exhibit No. 20, Your Honor, and marked for identification, and I will offer it.

Commissioner Lane: Are you offering it at this time?

Mr. Reilly: Yes, Your Honor.

Mr. Arseneau: Are you offering it now?

Mr. Reilly: I am offering it in evidence.

Mr. Arseneau: I would object at this time to the admission of this jacket in evidence, for the reason that if there is a battery in it, I do not think it has been connected with the testimony as to the type of battery, its structure and composition with respect to the claims here.

Mr. Reilly: Your Honor, I am perfectly happy to have Defendant's counsel take the exhibit and examine the battery in any way they choose, and tell us what they find.

Mr. Arseneau: I think it should be elicited by questions but not by Defendant's counsel.

Mr. Reilly: I am not trying to prove this battery, Your Honor. That is obvious. The purpose is to illustrate the utility of the water-activated battery.

Commissioner Lane: Is this a life jacket made for this purpose?

[fol. 161] Mr. Reilly: It comes from the British Overseas Airways Corporation, and I do not believe the battery was manufactured in the United States, but is merely a water-activated battery, and it shows that use of it in one field, which I think is particularly relevant because of its significance as to use, and that is all it was offered for.

Mr. Arseneau: My point is that it should be described in connection with this patent.

By Mr. Reilly:

Q. Doctor Mantell, do you have a pair of pliers with you?

A. I think I can find some.

Commissioner Lane: I have a pair of pliers in my office, if you want them.

By Mr. Reilly:

Q. Just break open the battery, and if you cannot do it with that instrument, we will get a pair of pliers.

A. (Witness complies)

Q. You have taken off the electrical connector from the end of the battery?

A. Yes sir, and I have also pulled out the little plug.

Q. Which permits the water to enter?

A. Yes, sir.

[fol. 162] (Continuing to open battery)

Mr. Arseneau: May it please the Court, my previous objection was based on the fact that Doctor Mantell has not testified that that battery was constructed in accordance with the teachings of the patent. If he is so able to testify, all right. I do not want to give the impression that I insisted on the battery being dismantled.

By Mr. Reilly:

Q. Doctor, if you can describe the construction of this battery by its parts, will you do so?

A. Your Honor, it would appear that the outside two strips which I have bent down so that they are parallel to the table, they would appear to be a magnesium metal, and the inner strip appears to be—and here is where my guessing comes in, which needs to be backed up by technical anal-

ysis—the inner strip appears to be electrolyte silver chloride on a silver strip.

Q. What are those little plastic things, Doctor?

A. These appear to be spacers on the magnesium to prevent contact.

Q. Do you mean to maintain something?

A. To maintain spatial relationship.

Commissioner Lane: Would it be sufficient to put it in along with Doctor Mantell's testimony?

[fol. 163] Mr. Reilly: Will it be Plaintiffs' Exhibit No. 21? It is the battery from a life jacket, intended for use in overseas aircraft.

Commissioner Lane: The jacket is withdrawn, and it will be Plaintiffs' Exhibit No. 20.

Mr. Reilly: I do not want the jacket withdrawn, but we will keep it here as designated and the battery we will keep here. Plaintiffs' Exhibit No. 20 is available to Mr. Arseneau at all times.

(Life jacket together with battery marked Plaintiffs' Exhibit No. 20 and received in evidence.)

By Mr. Reilly:

Q. Doctor, by getting off on the battery I took us off the advantages which we were discussing. You had gone down through a list on page 2, and I believe you had covered just about all of it down to operation under high temperature conditions.

A. We had covered that.

Q. Did you get below that?

A. We had covered the low cost and discard when exhausted, meaning that it could not be recharged like a storage battery.

Q. And that is where we pointed out this was continuous power rather than intermittent?

[fol. 164] A. Yes, sir.

Q. On the second line there, Doctor, do you agree that this battery is relatively simple and durable?

A. Yes, sir.

Q. Doctor, we discussed a low-temperature operation of the battery, and we have discussed a high-load condition of the battery, and you reported on what the functions were

under conditions where you operated the battery and combined the low temperature with the high load. I ask you what happens when those two are combined together with respect to the over-all output of the battery?

A. The over-all output is approximately the same, although actually would be reduced. So that if you apply a room temperature voltage curve and a capacity curve, and then on the same graph plot a low-temperature voltage and capacity curve, the low-temperature curve would be below the room temperature curve, and that would indicate that it is not the same capacity, although when I use the word "approximately," I am referring to perhaps ten or fifteen per cent difference.

Q. Have you found conditions of operation, where the decrease in over-all output will be in excess of fifteen per cent?

A. No, but I imagine batteries could be designed for [fol. 165] specific cases, and would be almost the same for fifteen per cent difference.

Q. Doctor, do you know of any other type of battery which under conditions, say, of −50° Centigrade, and a considerable overload for the battery size it will deliver 85 per cent of its ordinary capacity at room temperature with a normal load?

A. No, this type of magnesium device, magnesium battery is unusual in that respect, as compared with other battery systems.

Q. And under the conditions of −50° Centigrade and at overload, do you still find the output level—and by that I mean level in the sense of level voltage and level amperage?

A. Yes, sir, it is not so absolutely level that there could not be some slight divergence or curve, but it is approximately linear in the sense of being constant.

Q. Is it as linear as it is at room temperature?

A. Yes, sir.

Q. Doctor, we have gone on through the list of characteristics by combining what he said on page 1 with what Mr. Adams said on page 2. What battery systems have all these characteristics?

A. Only the water-activated magnesium batteries.

[fol. 166] Q. I want you to name the components of the battery system, so that it is clear in the record.

A. The magnesium and cuprous chloride system and the magnesium-silver chloride system.

Q. What is the specific subject matter of the patent in suit, Doctor?

A. The specific subject matter of the patent in suit is a battery system of magnesium and cuprous chloride.

Q. Is there ever anything additional to the cuprous chloride?

A. Cuprous chloride may have what is termed in the patent a catalyst carbon added to it, so that it makes the system magnesium-cuprous chloride-carbon, and there is also the other conductor, copper, as a contactor to complete the circuit, and that would be associated with the cuprous chloride.

Q. Does it have a conducting electrolyte in it?

A. In operation it has the equivalent of a conducting electrolyte. As initially formed, it does not have any electrolyte, and when water is added, that does not initially function as an electrolyte, inasmuch as its resistance is high enough to be classified as insulating. This makes the system, when it is activated, as one in which you have magnesium, water-activated cuprous chloride or cuprous chloride-carbon, and an electrical conductor from the cuprous [fol. 167] chloride.

Q. Doctor, how long has magnesium been available?

A. Magnesium was discovered as a metal about 1854 by electrolysis, and it was available before 1900, and it was produced by Dow in the United States from about 1915 on, and Dow went in and out of the magnesium business about three times. It was produced in Germany and England before the turn of the century and continuous from then on.

Q. Was it commercially available in this country during the First World War?

A. Yes, sir.

Q. Doctor, in what form does cuprous chloride come?

A. Cuprous chloride ordinarily comes as a white-greenish-yellow powder, as they combine CuCL without water of hydration, in other words it is anhydrous, and it is in the form of a powder, conveniently, and sold in dark glass bottles because it is so photosensitive.

Q. Doctor, you say it is sold in dark glass bottles because it is photosensitive?

A. Yes, sir.

Q. Is this the type of jar you are talking about? (Exhibiting jar)

A. Yes.

Q. Does that contain cuprous chloride?

[fol. 168] A. This contains cuprous chloride.

Q. Doctor, is this poisonous?

A. It is ordinarily so considered.

Q. And is the material in there the normal way in which this kind of material is sold commercially?

A. Yes, sir.

Q. Can we open that?

A. Yes, sir.

(Opening jar)

Q. Doctor, could we pour a small amount of that out on a piece of paper, so that the Court can see exactly what this material looks like, as it is available?

A. (Witness complies)

OFFERS IN EVIDENCE

Mr. Reilly: I will offer the jar of cuprous chloride to which the witness referred as Plaintiffs' Exhibit No. 21.

Mr. Arseneau: No objection.

Commissioner Lane: It is received.

(Jar of cuprous chloride was received in evidence as Plaintiffs' Exhibit No. 21.)

By Mr. Reilly:

Q. Doctor, is cuprous chloride soluble in water?

A. It is not so considered. The solubility is of the order of approximately six parts of cuprous chloride to 100,000 parts of water, so that by that figure it would be insoluble.

[fol. 169] Q. What happens if you add water to some cuprous chloride, such as we have had out on this paper?

A. Adding water, depending upon the amount of water, it will wet it, and if you add more water it will slurry, and if you continue to add more water, the slurry will become thinner and thinner.

Q. What happens, Doctor, if you dry the slurry out?

A. If you dry the slurry out, you will recover the cuprouse chloride in very nearly the same condition as you started with it, except that the powder tends to cement or conglomerate together.

Q. In other words, if you add a small amount of water, say of the nature of thirty parts of water to one hundred parts of cuprous chloride and mix it up, it will liquefy, is that correct?

A. It will liquefy and will be pourable as a slurry.

Q. If you put it into a mold, or if you spread it on a grid and leave it alone, what will happen to it?

A. It will harden into a mass.

Q. Will the chemical properties be changed from the chemical properties of the material originally?

A. Essentially, no.

Q. What happens after applying heat to the powdered [fol. 170] cuprous chloride?

A. If you add heat to the powdered cuprous chloride, and you apply it long enough and in sufficient quantities to reach the melting point, approximately 422, the material will melt and change from a solid to a liquid.

Q. 422° Centigrade?

A. Yes, sir.

Q. Doctor, what happens if you pour it into a mold and remove the heat?

A. If you pour it into a mold, it will assume the shape of the mold, and as it loses heat, solidify. If you did not pour it and left it in the mechanism in which you melted it, it would assume the shape of this container and solidify, if you removed the heat.

Q. When it solidifies, is it in one piece, Doctor?

A. When it solidifies, it is in one piece.

Q. Is it unified?

A. It is unified.

Q. Are the chemical properties changed when you heat this thing up and take the heat away?

A. Essentially, no.

Q. Suppose you use an organic liquid such as toluene or benzene and mix it in, what would happen?

A. It would liquefy the mix depending what you did to [fol. 171] solidify it, if you let it dry you would recover

the cuprous chloride, and your solvent would be eliminated by evaporation, and the chemical materials would be the same as at the start.

Q. If your proportions are in the proper order, would you get a fusion of cuprous chloride?

A. Yes, sir, you would get a fusion of cuprous chloride.

Q. Would you get a fusion by any of these methods?

A. Yes, but some of them might be stronger.

Q. And in all of them the chemical properties are relatively unchanged?

A. That is correct.

Q. Did I ask you to describe briefly the chemical properties of cuprous chloride? You mentioned photosensitivity and also that it is insoluble in water. What about its insolubility in acids?

A. Its insolubility is increased by various acids and by various salts, particularly those of the chloride and halide type.

Q. Doctor, with these few characteristics in mind, are there any other substances which have the chemical characteristics of a like nature?

A. To a degree, silver chloride has chemical character-[fol. 172] istics of a like nature. It is insoluble, and its insolubility is increased by things like ammonia chloride and ammonia, which increases the solubility of cuprous chloride, and its melting point is not too far away from cuprous chloride melting point, and it functions similarly in battery systems, and in general these are two cousin type materials.

Q. Is silver chloride also photosensitive?

A. Silver chloride is also photosensitive to a greater degree than cuprous chloride.

Q. Doctor, is carbon available as a powder?

A. Carbon is available as a powder in many different forms, as coal, as graphite, as charcoal, as carbonblack, as lampblack and as diamond powder, which is a conventional polishing material.

Q. Is carbon powder, any kind of carbon powder, soluble in water?

A. Not at all.

Q. Can you melt it by heat, Doctor?

A. If you refer to carbon as the elemental form, which

I am sure you do, we do not know how to melt carbon. We do know that at 3600° Centigrade it has a degree of solubility but in order to melt it we have to do it under unusually high pressures, and under those conditions we [fol. 173] might be able to melt carbon.

Q. When you say it has a degree of solubility at certain temperature, is that where it passes from the liquid to the gaseous state?

A. It passes from the liquid to the gaseous state without passing through a liquid form or state.

Q. Sublimation?

A. Yes. "Sublimation" means going from solid to gas and back to solid.

Q. Doctor, referring to column 1, page 1, line 21, what does Adams describe in what he terms the "embodiment selected for illustration"?

A. It is probably easier to describe this by looking at the drawing of Figure 1 of the patent. What he has there is container 10, and that container encloses a magnesium electrode 14, the outside of which is covered with a coating of tar 24. Inside of the magnesium electrode, and probably visualized a little better by referring to Figure 3, there is a cylinder which he terms electrode 26, and that is the cuprous chloride electrode, and inside of that he has a copper coil embedded, that copper coil being 34.

He also refers to the same cuprous chloride electrode by the designation 36. He supports the cuprous chloride electrode on a little platform 40, and the magnesium electrode [fol. 174] on little so-called notched ears 18. There is a terminal on the magnesium electrode which he designates as 14, which terminal is 22 for external electrical contact.

The cuprous chloride electrode 36 would be embedded in copper coil 34 as a terminal, which is marked plus on the drawing, and that terminal is 28. There is a cover 12, a liquid level 46, a vent 42 and a cover for the vent, which is 44. The cuprous chloride electrode is central, and the magnesium electrode is concentric with it in Figure 1 in the drawing.

Each one has a terminal for external electrical connection.

Q. Doctor, are the terminals you just mentioned exterior of the battery?

A. The terminals I just mentioned are exterior of the battery and they are above the cover.

Q. Is the cuprous chloride electrode a solid cylinder?

A. It is a solid cylinder, and it is so illustrated in the drawing.

Q. Is the magnesium electrode a hollow cylinder?

A. It is, and so indicated in the drawing.

Q. The purpose of the notched ears 18 and the platform which is designated as 40, are they not provided to align [fol. 175] the two cylinders cylindrically with reference to each other?

A. They are provided to align two cylinders cylindrically, one inside the other, and maintain their inner surface distance.

Q. Doctor, at the time of the Adams application, December 18, 1941, was this physical form of battery construction—I am talking about the round container, a cylindrical electrode and a solid cylindrical electrode, within the first cylindrical electrode—was that a known way of making batteries?

A. It was very commonly used and has been used for a half century or more.

Q. Doctor, starting with column 2, approximately at line 6, how does Adams teach making his cathode in the embodiment selected for illustration?

A. He teaches in this specific embodiment that he places cuprous chloride in a crucible, and on top of the cuprous chloride he places wood carbon. He then applies heat to a temperature range between 400° and 500° Centigrade. He says at the temperature the cuprous chloride may be poured. In other words, he wants to make it pour. He has previously, or simultaneously, arranged a mold with a coil, and he located the coil in the mold, and when the cuprous chloride is pourable, he transfers it to the mold from the heated crucible, and allows it to solidify. He has [fol. 176] blended the cuprous chloride and his carbon to begin with, and he makes them liquid, or liquefies them by heat, and makes them in that form and removes the heat and it results in a unified structure or electrode.

Q. Doctor, I would like to clear up one thing in the specification. I note in line 22 it is stated that he takes the cathode out of the crucible. As I recall, you testified

he got the melted fluid material into the mold. Does he mean that he takes the cathode out of the mold or out of the crucible?

A. It can be interpreted in two ways. For example, that it is an obvious error, which is easily understood, and, in the second way, the crucible could be the mold. We follow the practice, Your Honor, in which we take test tubes and melt the cuprous chloride in the test tube, and let it cool, and it was a simple way for us to make electrodes. In my opinion, this is just an error here and it means "mold."

Q. Doctor, referring to column 2, line 7 of page 1, by what term does he refer to his cuprous chloride-carbon electrode?

A. He refers to it as "comprises fused cuprous chloride."

Q. In terms of his description which you have just referred to, what does this mean?

A. This term "fused" means the entire operation of [fol. 177] blending and passing through the various steps there and on up with a unified structure. It refers to the final product and not a step in the manufacture of the product. Certainly in the language here "fused" does not mean "melted by heat." It means much more than that. Adams indicates that by the way in which he uses the term "fused cuprous chloride."

Q. Doctor, you have stated that the specific illustration or the illustrative embodiment shows the specific means of liquefaction and solidification to be the heat and the withdrawal of heat. Does the description in the patent anywhere state that heat, and the withdrawal of heat, is the only way in which the unification of the powder into an electrode is accomplished?

A. On page 2——

Q. Answer yes or no.

A. The answer is it does not so limit it.

Q. What are you referring to on page 2?

A. On page 2 I am referring to the statement:

> ". . . the foregoing will so fully illustrate my invention, that others may, by applying current knowledge, readily adapt the same for use under various conditions of service."

Q. Doctor, aside from the patent, what does the word "fused" mean generally?

[fol. 178] A. "Fused" generally means to incorporate, to blend, to unify, and occasionally in specific cases it might have a broader or a narrower meaning.

Q. Does it also mean to liquefy?

A. It could mean to liquefy because we do refer to things such as fusion points instead of melting points.

Q. Does Adams use the term "fuse" incorrectly?

A. In my opinion he does not use it incorrectly but he uses it correctly to interpret what he does.

Q. Do you mean it is his own personal use?

A. It is his own personal use of the word.

Q. What is the substance of how you evaluate what he means by the word "fuse"?

A. I understand his word "fuse" to mean blend, incorporate and unify.

Q. Doctor, is the Adams method of making his cathode with heat, and the withdrawal of heat and the use of a mold, novel with him?

A. Not at all. It has been well known.

Q. As far back as what year, would you say, Doctor?

A. 1880 or 1885.

Q. People were making electrodes for batteries by that process that long ago?

A. Yes, sir.

[fol. 179] Q. Doctor, without trying to catalog the entire thing, but at the time of the Adams application, let us say December 18, 1941, what other methods were known and old in the art for the purpose of making solid electrodes?

A. There were methods of pasting, and there were methods of electroplating, and there were methods of forming by pressure, with or without heat, and there were methods involving heat and the withdrawal of heat; there were methods involving the addition of water and forming paste or the addition of resinous materials to form paste, and the application of these on some supporting structure, all with the one common object that they wanted to unify or get a composite electrode.

Q. Doctor, was it also known in the art to add materials such as natural resins or the early plastics, such as

Bakelite to the electrode material to assist their unification?

A. Yes, sir.

Q. Doctor, you say the purpose of these methods is to unify. Why is it important to get it into one piece?

A. It is important to get it into one piece so that it will have a structure to which you can make your electrode connection, and it will stay there.

Q. The purpose of this thing is to be electrically conductive?

A. Either electrically conductive or have a contact to [fol. 180] it which will make it a part of the electrical system.

Q. Doctor, describe how they made electrodes for the type of lead storage batteries which you find in the present day automobile, and describe it as of an early date, whenever these batteries were first made. You know better about that than I do.

A. These were made by casting a lead plate formed with recesses making squares and buckets, and then put in oxides of lead, with sulphuric acid and water with the constituents, to prevent expansion, and they were added together and putting it on through means of a spatula or through rolls or adding it mechanically in some way.

Q. You described the cast lead plate. Was that somewhat in the form of a grid or screen?

A. Yes, it was in the form of a grid or screen, and might look like a copper wire.

Q. Then you would take sulphuric acid and water and other stuff is added?

A. Yes, sir.

Q. What did they do with the water, lead oxide and sulphuric acid, when put together?

A. They ground it up.

Q. They ground it up into a paste, Doctor?

A. They ground it up, or it was previously ground up [fol. 181] into powder,

Q. And they took this material and put it into the plate?

A. Yes, sir.

Q. And that was called pasting?

A. That was called pasting.

Q. How far back did they make batteries that way?

A. To my knowledge, from the time I saw it in 1920, and they had followed it long before I saw it.

Q. Doctor, was the pasting method so known by that term, and was it not used in primary batteries back in 1941?

A. Yes, it was used in primary batteries.

Q. How far back would you say paste goes?

A. It would be 50 or 60 years or more.

Q. How would 1850 or 1860 sound?

A. If I had time, I could find the year.

Q. I believe the reference I was looking for is the article by Niaudet, which I believe is relied upon by the Defendant here.

Doctor, on that reference I am referring to Elementary Treatise on Electric Batteries, from the French of Alfred Niaudet, translated by L. M. Fishback—a coincidence—and published in New York in 1880.

Do you have a copy of that?

[fol. 182] A. Can I get my copy?

Q. All right.

A. (Obtaining copy)

Mr. Reilly: There are a lot of references in there, Your Honor, but I was referring to the first page of the photostat, which shows the title page and the date.

By Mr. Reilly:

Q. On page 201, Doctor, and at the bottom of that page and page 202, I am referring to the work of one, Warren De La Rue. What does that last paragraph on page 201 indicate?

A. It reads:

> "These experiments possess in themselves but little interest. It is only since Warren De La Rue has given his attention to this battery that it has attained any importance, and that its use has become general."

Q. Doctor, what experiment is he referring to by that comment?

A. He is referring to an earlier battery of Marie Davy, which was an 1860 battery made of zinc, pure water, chlo-

ride of silver melted in a silver crucible, and which battery has worked with perfect regularity.

Q. What is the comment which he makes concerning the [fol. 183] battery which worked with perfect regularity in the last paragraph you read?

A. The last paragraph says:

"It was only since Warren De La Rue" used it that it has become important.

In other words, the battery system was known.

Q. On the top of page 202, Doctor, what does he say about how De La Rue worked with his chloride of silver?

A. He says that De La Rue, referring to him as "this physicist"—"used chloride of silver in the shape of a powder or paste, and his liquid was a thin solution of sea-salt."

Q. Thank you, Doctor.

Further down the page, about three paragraphs from the bottom, what does he say about another type of silver electrode?

A. He talks about one made out of a strip of silver, around which is melted a cylinder of chloride of silver, AgCl.

He illustrated that in the figure on the next page.

Q. You mean the one on page 203?

A. Which is labeled "Silver Chloride." It is labeled "AgCl."

Q. With a wire coming out of it?

[fol. 184] A. It is cylindrical with a wire coming out of it.

Q. Is that the way Adams made his electrode of cuprous chloride, Doctor?

A. Essentially.

Q. Is this electrode here referred to as "fused"?

A. It is not referred to as "fused," but this is melted.

Q. Thank you, Doctor.

In the next paragraph, what does he say about paper?

A. He says in effect that he uses paper between the two electrodes to avoid contact, and the words used are:

> "To avoid an accidental contact of the two electrodes, the rod of chloride of silver is placed in a small cylinder of parchment paper, A; there are two holes near the top of this paper cylinder, through which the strip of silver passes, as shown in B."

Q. The purpose of putting paper in there is to prevent accidental contact?

A. As a separator.

Q. The reason they want to prevent accidental contact is because they must be pretty close together?

A. They must be pretty close together.

Q. The point of this is that they put together a battery where the inter-electrode distance is small?

A. Yes, and they tried to get them as close together as [fol. 185] possible and not hit each other.

Mr. Arseneau: Your Honor, sometimes I do not know who is testifying. I wonder if the questions could be counched in a little less leading fashion?

Mr. Reilly: I will try. I am trying to move along faster, Mr. Arseneau.

By Mr. Reilly:

Q. Doctor, on page 204, would you note, please, in the last paragraph what is the reported advantage of a type of battery which we have been talking about in the previous pages?

A. The reported advantage is toward the bottom, ". . . this battery does not work upon itself."

It has absence of local or internal action as long as the electric circuit is open, and this is where zinc and ammonia chloride is used, and this absence of local action is an advantage.

Q. Doctor. the magnesium-cuprous chloride-water system is there . bsence of local action when the circuit is open?

A. When the circuit is open and when the battery has been enegized——

Q. By water?

A. By water, and there is not an absence of local action.

[fol. 186] Q. There is what?

A. There is a considerable amount of action.

Q. How long would the battery last if you just put the components together?

A. If you put the components together, including the liquid electrolyte component, only a short time, because the magnesium corrodes.

Q. In other words, the battery does not check itself?

A. The battery does not check itself and once started it cannot be stopped.

Q. Doctor, is this zinc-silver chloride system the same electrochemical system as the magnesium-cuprous chloride-water system?

A. No, it is not. This is a bell-ringing type of battery.

Q. Doctor, I believe you testified that the melted electrodes are close together. Did you also find in the material which we went through a disclosure of the pasted method?

A. Yes, the pasted method was referred to on page 202, where it is stated that he uses chloride silver in the shape of a powder form or paste.

Q. The date of this book is what, Doctor?

[fol. 187] A. The date of the book is 1880.

Commissioner Lane: We will have a luncheon recess when you get to a good stopping point, Mr. Reilly.

Mr. Reilly: Your Honor, this would be a good place, if it is convenient to you.

Commissioner Lane: We will recess until 2:00 o'clock.

Mr. Reilly: Thank you, that will be fine.

(Whereupon, at 12:30 o'clock p.m., a recess was taken until 2:00 o'clock p.m.)

AFTERNOON SESSION (2:00 o'clock p.m.)

Commissioner Lane: You may continue.

WHEREUPON CHARLES L. MANTELL, the witness on the stand at the taking of the recess, resumed the stand and testified further on behalf of the Plaintiffs, as follows:

Direct Examination (Resumed)

Mr. Reilly: I want to cover one or two points which I have been reminded of, and one of them is Plaintiffs' Exhibit No. 2.

Commissioner Lane: Mr. Arseneau, when Plaintiffs' Exhibit No. 2 was offered, you made an objection and said

you wanted to cross-examine Mr. Adams. Do you have any objection?

[fol. 188] Mr. Arseneau: I withdraw my objection.

Commissioner Lane: Let the record show that Plaintiffs' Exhibit No. 2 is received in evidence.

(The document heretofore marked for identification Plaintiffs' Exhibit No. 2 was received in evidence.)

Mr. Reilly: The other point I want to be sure is clear is that Plaintiffs' Exhibit No. 20, which was identified, offered and received, included both the disassembled battery and the life jacket.

Commissioner Lane: That is my understanding, that it does include both.

Mr. Reilly: Thank you, Your Honor.

I also mentioned this morning the article by Niaudet, and if I may have a moment, Your Honor, I want to confer with Defendant's counsel.

(Discussion off the record.)

Commissioner Lane: You may proceed.

Mr. Reilly: Your Honor, the article by Niaudet, which was referred to this morning in the testimony is a matter that I have discussed with Defendant's counsel, and we have agreed that it may be identified, Your Honor being willing, as Defendant's Exhibit No. 1.

Commissioner Lane: Do you have copies of it for the reporter?

[fol. 189] Mr. Reilly: I will hand up one to Your Honor. I want to further identify that we were talking about pages 200 through 209, plus the first page of the book, which gives the date, and the second page which is IX, a portion of the Table of Contents.

Commissioner Lane: Defendant's Exhibit No. 1 will be received.

(Copy of the cover page and page IX of the Table of Contents and pages 200 through 209 of book entitled "Elementary Treatise on Electric Batteries," from the French of Alfred Niaudet, translated by L. M. Fishback, dated 1880 was received in evidence as Defendant's Exhibit No. 1.)

Mr. Reilly: Your Honor, I would now refer to U. S.

Patent No. 434,593 to Fink, issued August 19, 1890. I will hand it up to you.

Commissioner Lane: Do you want to take the book back which you loaned to me?

Mr. Reilly: Yes, sir.

(Taking book from Commissioner.)

By Mr. Reilly:

Q. Doctor Mantell, will you refer, without reading it, to lines 16 to 51 on numbered page 1 of Fink and tell me what sort of method of making a cathode you find described there?

[fol. 190] A. That is a method of a zinc-silver chloride system in which the "chloride of silver is melted and cast in a mold in the form of a rod, around a longitudinal axis formed by a piece of silver wire placed in the center of the mold."

Q. Will you also look at Mr. Fink's drawings for the exact arrangement of his battery anode and cathode as described? I believe it is line 16. Yes, from line 16 down, and will you describe for us the structural form of his outside electrode and his other electrode?

A. He uses an electrode where "the cylindrical or tubular form as usually most convenient," and this is melted and cast into a silver chloride electrode.

Q. Is that a solid cylinder inside a hollow cylinder?

A. It is a solid cylinder inside a hollow cylinder.

Q. How does that relate to the structure of the cathode and anode or electrodes shown in the Adams patent?

A. It is identical in character with the specific example of the Adams patent.

Q. The physical structure?

A. The physical structure.

Q. And the method of making the cathode, as described by Fink, what relationship does that bear to the method of making the cathode shown by Adams?

A. Both use a cathode around which the silver chloride [fol. 191] or cuprous chloride is cast in the form of a cylinder.

Q. Does he say that the chloride of silver is melted and inserted in a mold?

A. Yes.

Q. Around a longitudinal axis formed by a piece of silver wire placed in the center of the mold?

A. I read that before.

Q. Yes, you did. Is it the same as Adams?

A. It is the same as Adams.

Mr. Arseneau: The Fink patent is Defendant's Exhibit No. 9 for identification.

(Patent No. 434,593 dated August 19, 1890 to William M. Fink, was marked for identification as Defendant's Exhibit No. 9.)

Mr. Reilly: We have agreed that the Fink patent shall be designated as Defendant's Exhibit No. 9, and we will stipulate to that at this time, and it shall be introduced without objection on our part, or, as a matter of fact, we will introduce it.

Mr. Arseneau: Our general policy has been to give the reporter a copy of everything.

Commissioner Lane: We will wait until Defendant puts on its case.

Mr. Reilly: We will wait until Defendant puts on its case [fol. 192] to have them offered and received.

Mr. Arseneau: Defendant's Exhibit No. 1 is the Niaudet article, and the Fink patent is Defendant's Exhibit No. 9.

Mr. Reilly: All right.

By Mr. Reilly:

Q. In Defendant's Exhibit No. 9, Doctor, is that electrode, that negative electrode or cathode of melted silver chloride termed "fused"?

A. It is not termed "fused."

Q. Doctor, in Defendant's Exhibit No. 1, which is the Niaudet article, where the batteries or electrodes are made of melted silver chloride, are they described in any way by the term "fused"?

A. No, the reference is: "Around which is melted a cylinder of chloride of silver."

Q. Doctor, in the same exhibit, Defendant's Exhibit No. 1, in referring to the pasted silver chloride electrodes, are they anywhere referred to as "fused"?

A. No, they are not referred to anywhere in the article as "fused."

Q. Doctor, referring to the book by Vinal, entitled "Primary Batteries," which I will ask that the record note was copyrighted in 1950, and I will ask that the record note that because it is not shown on the photostat that I have here— [fol. 193] in the first three pages, pages 1, 2 and 3, the original Volta battery, I believe is shown.

A. That is on page 3, in the drawing.

Q. On page 3, what is Figure 2?

A. Figure 2 is a pile, and the description says that the plate in the pile can be silver, brass or copper against tin or zinc, but he stated that silver or zinc were better than the others.

Q. Between the plates of silver and zinc, what did he put?

A. He placed pieces of cardboard which could be pasteboard or carton or animal hide or porous materials, which in more recent terminology has often been referred to as bibulous materials.

Q. What did he put on the bibulous material?

A. He soaked them well with water or some other fluid. which may be a better conductor than simple water, as salt water, and so forth.

Q. Doctor, when was this information from Volta made public?

A. Approximately 1800. It shows in the transactions of the Royal Society for the year 1800.

Q. I beg your pardon, Doctor. I thought that was an error. The first experiment that he made the was with the zinc plate, separated from a silver plate by a piece of [fol. 194] cardboard? That was the first experiment?

A. I don't know whether it was the first experiment but it was among his experiments.

Q. Doctor, I am going to refer you to some of these batteries which have been stipulated to have been procured and delivered to the Defendant within the six years next prior to to the date of this Petition. There is one of these batteries, Doctor, Exhibit No. 8, which is partially open at the bottom and top, and I would ask you to look at it, if you will, and describe to me the physical form and arrangement of the parts of the battery, Trial Exhibit No. 8.

A. This is a pile construction battery in which electrodes

have between them layers of paper-like or bibulous material, analogous to and identical to the character in Volta's pile.

Q. In physical form?

A. In physical form.

Q. In other words, is it what I would call an anode?

A. There is an anode and there is a cathode, and there is a separator.

Q. Between the anode and the cathode?

A. Between the anode and the cathode.

Q. Is that the same physical construction taught by Volta in 1800?

[fol. 195] A. It is the same physical construction except this is logitudinal, and Volta in much of his experimental work used circular plates, but the construction is identical.

Q. Did Volta stack his plates vertically?

A. Volta stacked his plates vertically because it was simpler.

Q. Now, Doctor Mantell, there is more than one cell in that battery, is there not?

A. There is.

Q. When I say "a cell," will you tell me what a cell is?

A. A cell, in contrast to a battery—we all know these terms are used interchangeably—would be one pair of anodes and cathodes or one pair of electrodes, supposedly inside. The term "battery" refers to a multiple of such cells.

Q. So a cell is one anode and one cathode?

A. With separators.

Q. A battery is one or more cells, it is not?

A. Yes, sir.

Q. Doctor, I am going to take off or open the top of Trial Exhibit No. 7, which is another one of these batteries as to which we have a stipulation that the Defendant procured them and had them delivered to them in the six-year period preceding the date of the Petition. Incidentally, as I open [fol. 196] the cover, the cells appear to be covered with paper and cotton. Can you tell me what kind of construction is shown in that battery?

A. I would say from the markings on the external circuit that these are pile-type batteries, and also looking at the construction, and that the group of them may be in series or parallel or in combination, depending upon how they are

electrically wired. They are, however, Volta-type pile-type batteries.

Q. In other words, there is an anode and a cathode separated by a layer of cardboard or some some kind of bibulous material?

A. Yes.

Q. Thank you, Doctor.

Now, Doctor, in the battery system that we have discussed —and I am referring to the magnesium-water-cuprous chloride system—given the same shape and size of the electrodes and the same arrangement of the electrodes in the battery, does the specific method of preparation of the electrodes, whether they be melted by heat or melted by water or any other solvent or organic material such as benzene or toluene, make any difference of substance in the operation of the battery?

A. No, it makes no difference of substance. There may [fol. 197] be minor differences in performance of the battery in terms of efficiency, depending upon the arrangement, but they are essentitally all the same system and will function in the same way.

Q. What considerations would determine whether in any given battery you chose to make a cathode of material by melting or blending by heat or melting or blending by water?

A. Only the type of situation which might have to be adapted to an existing manufacturer's set-up or to manufacturing considerations in terms of labor supply and efficiency of such labor.

Q. Are both of the methods referred to for making cathodes satisfactory?

A. Yes.

Q. Would the type of battery or the specific use you are intending to design it for determine the selection of which type or method might be used to make the cathode?

A. The specific application might cause you to prefer one form over the other.

Q. Doctor, what are the principal differences, if any, between these two methods of making cathodes which I have covered in the preceding question?

A. There are no essential differences, in that they both blend, liquefy and unify, to produce an electrode structure.

[fol. 198] Q. Will either one or the other be stronger or better adapted to the supporting material?

A. In my opinion the fused one might show better attachment that the non-fused one in many other ways. By the "fused one," I mean the complete unification. An unfused one might consist of a form in which powdered cuprous or silver chloride was placed in a bag against the supporting structure.

However, if each one went through the same steps of mixing, liquefaction, and then blending, and unification, the one processed by heat might give a little stronger attachment.

Q. You are comparing that with the one processed by water?

A. Yes.

Q. In your answer to the question you referred to a third type which was where there was a bag of powder just hanging around the center wire. Is that correct?

A. Yes, sir.

Q. By that do you mean the powder had not been unified?

A. The powder had not been unified.

Q. Is there any difference in initial activity between the melted-by-heat and the melted-by-water cathodes?

A. The melted-by-water cathodes might tend to activate a little faster than the melted-by-heat.

[fol. 199] Q. And referring to water with that initial activation advantage, does melted-by-water cathodes have any disadvantage?

A. The disadvantage of the melted-by-water cathode is in the form of adherence to the supporting structure.

Q. What is the effect of that?

A. That it may fall off at a time when it is not desired that it fall off.

Q. Could it cause a lessening of potential?

A. It must cause a lessening of potential, and particularly a lessening of capacity.

Q. Is that sometimes referred to as a short circuit?

A. No. It might cause a short circuit if enough contacted the electrodes by getting between them.

Q. In other words, when it just falls off, it reduces the amount of material available to be activated?

A. Yes.

Q. But if it falls off and gets between the two electrodes, that is what is called a short circuit?

A. It might then be.

Q. Doctor, is there any difference in the porosity of the electrodes, where the material is melted by heat and one where it is melted by water?

A. If it is desired to achieve the same porosity, this may be achieved in both cases.

[fol. 200] Q. How is that done?

A. By the addition of other materials.

Q. Doctor, is there ever a problem with over-porosity or over-activity in either of the melted-by-water or the melted-by-heat cuprous chloride cathodes?

A. There can be, if an active addition of carbon be made, and a specific form of carbon, such as an activated or absorbent carbon be employed, and the porosity may be greater than that desired.

Q. Doctor, I want to vary the form of my question. I understand your answer, but the point I want to get at is this: We are talking specifically about the melted-by-water cathode. Has there been criticism in the art concerning the characteristics of porosity or activation?

A. There has been criticism in the art.

Q. What is the criticism?

A. The criticism is that they may be over-active or they may have unsatisfactory adherence, and a tendency to fall off because of lack of adherence.

Q. What does that art teach to remedy the condition of over-porosity?

A. The ones who made the criticism of a melted-by-water electrode suggested the addition of adhesive materials, such as binders, resins, plastics and the like.

[fol. 201] Q. Does the addition of such materials as you have mentioned have any effect on the lack of adhesion of the melted-by-water material, either to itself or to the grid or screen or wire to which it is adhered? Do I make myself clear, Doctor?

A. No, because you are talking about plastics in the previous question, and plastics are not aided by heat.

Q. Read the question.

(Question read.)

I am referring to the melted-by-water electrode, Doctor, and the question I am asking is, if you put the resin which you mentioned in it, does the addition of the resin to the water-melted cathode affect the abilities of this material to adhere to the grid?

A. The efficiency of binders and adhesives, such as resins and the like, improves the adhesion, but it may also, if carelessly done, decrease the effect of the cuprous chloride by coating it and making it non-available.

Q. Doctor, in any event, what effect does the resinous material have on the operation of the battery?

A. In general it tends to decrease the activity of the cuprous chloride but that may be compensated for in the design so that the over-all net effect is small.

Q. Doctor, if you add thirty per cent by weight of resin [fol. 202] to 100 per cent by weight of cuprous chloride, what happens to the effective weight of the total battery?

A. You may coat part of it with cuprous chloride and thus reduce the effective weight or the effective action of the cuprous chloride.

Q. I understand the reduction of the effective action, but is it not true that if we add thirty per cent of resin by weight to cuprous chloride, and if the cuprous chloride makes up 50 per cent of the weight of the battery, then the weight of the battery has to be increased roughly 15 per cent?

A. Yes.

Q. Then the addition of the resin must add a weight factor which does not in any way act to increase the cuprous chloride activity?

A. In the design that would be called for by greater amounts of cuprous chloride.

Q. I realize that you can compensate for it, but if the battery is going to run as desired, for instance in a balloon, then that is the case?

A. That is the case.

Q. If you provide a heavier battery, then you must have a greater weight-lifting force in the balloon to get it up?

[fol. 203] A. Yes sir.

Q. Therefore you do not have the same efficiency per unit of weight, which you referred to in discussing the advantages of the Adams battery in the initial part of your testimony? Is not that correct?

A. That is in general correct.

Mr. Arseneau: If the Court please, I would like to shift the testimony back to the witness, if there is no objection.

Mr. Reilly: It is quite obvious that the witness missed my point and I was trying to get back on the track. I am not sure whether you missed my point or I did not make it clear.

By Mr. Reilly:

Q. Doctor, what is the function of the carbon in the cathode battery system of a magnesium-cuprous chloride plus a carbon and water system, disclosed by Adams?

A. Broadly the effect of carbon in the systems generally is to add an electronic conductor, which in turn decreases the resistance of the cuprous chloride.

Q. It adds conductivity?

A. It adds conductivity.

Q. Doctor, did you perform any experiments on that subject?

[fol. 204] A. Yes, we measured the conductivity of melted cuprous chloride.

Q. Melted by what?

A. Melted by heat, and we measured the conductivity of cuprous chloride paste, and we measured the conductivity of cuprous chloride melted by water, to unify, and we measured the conductivity of cuprous chloride to which carbon was added.

Relatively, the values, as I remember them, were that the cuprous chloride alone had a vlue of 100. The effect of the addition to cuprous chloride of carbon dropped it down on the same scale to five to ten. The effect of the melting by water dropped it down to about 50.

Q. Does the function of carbon have any contribution to porosity?

A. The carbon adds to the porosity.

Q. Doctor, in the preceding experiment, did you set up cells which were melted by heat, with or without carbon?

A. In a separate series of experiments we set up cells in which we had electrodes with melted cuprous chloride without carbon, and melted cuprous chloride with carbon, water-melted cuprous chloride alone, and water-melted cuprous chloride with carbon. We short-circuited these cells and

noted the temperature rise. In the two cells in which we had carbon, the temperature rise on the short-circuited cell was [fol. 205] very much more rapid than those which did not contain carbon.

For this reason, we felt that we were in agreement with Adams' statement that carbon was adding a catalytic effect in that it accelerated the reaction under the same set of conditions.

Q. I want to be sure that I understand the experiment. In other words, you built four complete cells with magnesium anodes and cuprous chloride cathodes, and two of the cuprous chloride cathodes were melted by water, and two of the cuprous chloride cathodes were melted by heat?

A. Yes, sir.

Q. And one of each pair had carbon, and one of each pair did not have carbon?

A. Yes, sir.

Q. Then you dumped all four cells in water, or was it in water?

A. In water.

Q. And you noted right away that the activity and the temperature rise was greater with the ones with carbon rather than those without carbon?

A. Over the same period of time?

Q. Over the same period of time.

A. Yes, sir.

Q. Did you postulate from that that the carbon had an [fol. 206] effect regardless of whether it was melted-by-heat or melted-by-water cathodes?

A. I did.

Q. From that do you feel that Adams may have known something about what he was talking about when he called carbon a catalytic agent, as he does on lines 17 and 18 of this patent?

A. I felt that the word could be justified in that the usual definition of a catalyst would have been indicated here.

Q. Doctor, may I ask a question concerning your personal reaction? Before you made any experiments and when you first read the patent, what did the word "catalyst" in connection with carbon mean to you, or what did you think about it then?

A. I was extremely skeptical.

Q. Carbon is old and well known in the art, is it not, Doctor?

A. Extremely well known in the art.

Q. What are the purposes for which it has been used in the art?

A. One of the major purposes of carbon in the art is illustrated by the addition of carbon to manganese dioxide, in the ordinary dry battery. Other forms are graphite or [fol. 207] other carbons which show graphite structures under the X-ray, typical of which is Shawinigan Black, which is made from acetylene and some furnace blacks, made from oil.

Q. What are these carbons good for? What are they used for?

A. In the manganese dioxide it is used to decrease the resistance.

Q. That is the usual function of such carbon? Is that it?

A. That is right.

Q. Conductivity?

A. Yes, sir.

Q. Doctor, do you use carbon in silver chloride-water-activated batteries?

A. Conventionally, no, because you can do an easier job by the use of silver.

Q. Doctor, referring to page 1, column 2, lines 42 to 45 of the patent in suit, what effect does the addition of sulphate of magnesium, discussed in those lines, have on the operation of the battery?

A. If and when it is done that way, it tends to keep the surface of the magnesium a little cleaner.

Q. Will the cuprous chloride-magnesium-water-activated batteries work without it?

A. Yes, sir.

[fol. 208] Q. What is the effect of adding the magnesium chloride mentioned on page 2, column 1, lines 3 to 6?

A. The effect of the addition of magnesium chloride is to shorten the time, in that it more rapidly sets up an electrolyte available to the battery.

Q. Will cuprous chloride-magnesium batteries work well without it?

A. Yes, sir.

Q. What does the output curve look like, with or without it?

A. The activation period, that is the rise of voltage in the cell, takes a longer time, but after that the curves are similar. They both show a flat top, a linear section, parallel with respect to the voltage and amperage.

Q. If one was started and had the same active life, and the other was run slower and had the same active life, it would be shifted time-wise with respect to the graph?

A. Yes, sir.

Q. Referring to page 2, column 1, Doctor, lines 7 to 16, referring to the Adams patent, will you please state whether in your opinion the Adams battery system or the battery systems disclosed in this patent are, first, simple?

A. They are simple. They consist of magnesium metal and cuprous chloride.

[fol. 209] Q. Are they durable?

A. They are durable to the extent for which they are intended and designed.

Q. Are they light in weight for their capacity, compared to other batteries?

A. They are light in weight for their capacity as compared to other batteries.

Q. Do they show a linear potential?

A. They show a linear potential, using the word "linear" in the sense that Adams used it.

Q. I'm sorry. They would show a level potential?

A. They show a level potential.

Q. And they also show a level amperage?

A. They do.

Q. Will they operate under temperature conditions in the range from 150° above Fahrenheit to the range of −50° below Centigrade?

A. The system can be designed properly within the temperature range of −50° Centigrade to ±150° Fahrenheit.

Q. Are they cheap, Doctor? I mean are their components cheap?

A. Their components are cheap.

Q. Do they function under conditions such as occur with an intermittent operation battery?

[fol. 210] A. Once started, they do not stop. They do not have the characteristics of a bell-ringer type battery.

Q. Do they show unusual or a relatively small decrease in efficiency, over-all efficiency, when operated under conditions of low temperature, such as −50° Centigrade and an overload condition which I will define as being less than five times the normal load condition for the battery to produce a non-exothermic reaction?

A. They operate with comparable efficiencies, although the low temperature operation curves will be below the curves where you continue to operate at room temperature.

Q. When you say "below," do you mean substantially below or not substantially below?

A. Not substantially below.

Q. Doctor, what other type of battery systems contains all of these same advantages?

A. No other type of battery systems contain all these advantages of level potential, level capacity, operation over a wide range of temperature, and lightness per unit of capacity, inexpensiveness and ease of activation.

Q. Which ones are you including in your answer?

A. I am including the magnesium-cuprous chloride and the magnesium-silver chloride systems, with or without carbon.

[fol. 211] Q. With or without carbon refers to the magnesium-cuprous chloride?

A. Yes, sir.

Mr. Reilly: Could we take a short recess at this point, Your Honor?

Commissioner Lane: Very well, ten-minute recess.

(Short recess.)

Commissioner Lane: You may proceed.

By Mr. Reilly:

Q. Referring to the claims, Doctor, what are the elements in Claim No. 1?

A. The elements of Claim No. 1 are "a liquid container, a magnesium electropositive electrode inside the container and having an exterior terminal, a fused cuprous chloride electronegative electrode, and a terminal connected with said electronegative elecrode."

Q. Doctor, what are the elements in Claim No. 10?

A. They are, "a magnesium electropositive electrode, and an electronegative electrode comprising cuprous chloride fused with a carbon catalytic agent."

Q. Is there any limitation in Claim 10 as to the physical shape of the battery?

A. There is not.

Mr. Arseneau: Your Honor, I have no hesitation in re-
[fol. 212] ferring to the fact that Doctor Mantell is qualified as a very renowned electrochemist, but as a person skilled technically in Electrochemistry he has not been qualified as a patent agent or a patent attorney, and I believe any questions directed to that specific field in the claims are out of order.

The qualification of the witness has not been broad enough to cover construing a patent, especially where a word of limitation is used.

By Mr. Reilly:

Q. I will rephrase the question. Is there any element in Claim 10 describing the physical shape of the battery?

A. No.

Q. Doctor, referring to page 7 of the Adams file wrapper, which is Trial Exhibit No. 11—which I will have to get a copy of for you—and referring to Claim 1, what amendments were made to Claim 1 during the prosecution?

A. "... electropositive electrode...." was substituted for "cathode," and "electronegative electrode" was substituted for "anode," and "electronegative electrode" was also substituted for "anode."

Q. Why was that done, Doctor?

A. It was a question of terminology. Adams had originally used a European terminology, and it was made to
[fol. 213] conform with American terminology.

Q. Referring to Claim 10 of Trial Exhibit No. 11, what happened to Claim 10?

A. In Claim 10 the word "pure" was deleted in referring to magnesium and "cathode" was changed to read "electropositive electrode," and "anode" was changed to read "electronegative electrode."

Q. Doctor, referring to page 4 of this Trial Exhibit No. 11, in the last paragraph on page 4 what occurred between

the time this patent application was filed and the patent issued?

A. Again there was a change of terminology so that the electronegative and electropositive terms were used.

The term "core" was changed to "body," and the word "crucible" was changed to "mold."

There were added the words "poured from a heated crucible," after the words "the requisite amount of cuprous chloride."

The word "then" was removed and after the words "on the top of the cuprous chloride," the words "in the crucible" were added.

In the same line the words "fused at" were changed to read "heated to," and after "400° and 500° Centigrade," the words were added, "at which the cuprous chloride may be poured."

[fol. 214] Up above, however, the word "fused" in the full line reading, ". . . comprises fused cuprous chloride" remained, indicating that the specific remaining "fused" was a different word and a different meaning from "heated to," or "melted."

Q. Doctor, is there any novelty or distinction in the art prior to Adams between "flat plate electrodes" and "cylindrical solid electrodes"?

A. They were both employed in a large number of battery systems.

Mr. Reilly: May I have Trial Exhibit No. 8, please, Your Honor?

Commissioner Lane: Yes, sir. (Producing Trial Exhibit No. 8)

Mr. Reilly: Thank you.

By Mr. Reilly:

Q. Doctor, I hand you Trial Exhibit No. 8. Is it a battery?

A. This is a battery.

Q. Does that battery have a liquid container or retainer?

A. It has a liquid container which is also a retainer, in the form of the bibulous material for the spacer.

Q. Doctor, can you tell whether the battery has a magnesium electropositive electrode?

[fol. 215] A. I can't tell positively without ripping it apart.

Mr. Reilly: Mr. Arseneau, do you have any objection to our looking into the interior of this battery?

Mr. Arseneau: No, I have no objection.

By Mr. Reilly:

Q. Doctor, would you please do whatever you can about that, and before you disturb too much of it, Doctor, let me stop you for just a moment.

A. Yes, sir.

Mr. Reilly: Could we pass it around so that His Honor may view it?

(Showing battery to Commissioner)

Mr. Reilly: Do you wish to view it, Mr. Arseneau?

Mr. Arseneau: For just a second, if you do not mind.

Mr. Reilly: Surely.

(Handing Trial Exhibit No. 8 to Defendant's counsel)

Mr. Arseneau: Here you are.

(Returning Trial Exhibit No. 8.)

Mr. Reilly: Thank you.

By Mr. Reilly:

Q. Now, Doctor, can you ascertain whether the battery does or does not have a magnesium electropositive electrode?

A. It would appear to have a magnesium electropositive electrode.

[fol. 216] Q. Doctor, will you describe whatever piece of the battery you are looking at or holding, which appears to be the magnesium electropositive electrode?

A. It is the outer piece which would have been under the cover, in that I slid the cover, which is a plastic cover, and there is a magnesium electrode.

Q. Does the electrode appear to be corroded?

A. Yes, the electrode does appear to be corroded.

Q. Doctor, is the magnesium electropositive electrode, or any of those magnesium electropositive electrodes, if there

are more than one, inside the water or the liquid container?

A. Yes, there appears to be more than one.

Mr. Reilly: Will you read the question back, please, Mr. Reporter?

(Question read.)

By Mr. Reilly:

Q. Are any of the magnesium electropositive electrodes inside the liquid container?

A. Yes, the inner surface of the magnesium, adjacent to the bibulous material, is inside the container.

Q. The liquid container?

A. The liquid container.

Mr. Arseneau: May I interrupt a second to ask what was [fol. 217] identified by the witness as the container? I am afraid I missed it.

By Mr. Reilly:

Q. What part did you identify as the container?

A. The bibulous material.

Q. The bibulous material?

A. Yes, sir.

Q. Where is the bibulous material located in reference to the magnesium electropositive electrodes?

A. The magnesium is on the outside of the bibulous material and adjacent to it. The inner surface of the magnesium becomes a portion of the container inasmuch as it is immediately adjacent to it and forms the base.

Q. Is it the container?

A. It is the container.

Q. Doctor, would the battery operate, if the magnesium electropositive electrode were not against the bibulous material in a face-to-face relationship?

A. No, it would have to be in a face-to-face relationship.

Q. Doctor, you are referring to the external magnesium electrode, I believe. There are more magnesium electrodes than the one to which you are referring?

A. There appears to be more than one although the bat- [fol. 218] tery is so corroded that it is difficult to determine it. There are more than one.

Q. Doctor, with other ones, other than the first magnesium electrodes to which you referred, how are they located with reference to the bibulous material?

A. In the face of the magnesium electrode—and it may be inside of both faces of the magnesium—the electrode contacts bibulous material, and so in this case each face becomes a part of the container.

Q. There is, then, in relation to certain of the magnesium electrodes bibulous material on both sides?

A. Yes, sir.

Q. Doctor, does the magnesium electrode, or any of them, have an exterior terminal, that is a terminal exterior to the liquid container?

A. They do have terminals exterior to the liquid container.

Q. Will you just point that out to His Honor?

A. (Witness complies)

Q. Does the battery have, if you can tell, a cuprous chloride electronegative electrode?

A. It would appear to have a cuprous chloride electronegative electrode because of the green colorations.

Q. In what state does cuprous chloride take on whatever [fol. 219] coloration you may be describing, Doctor?

A. It would take on such a state after contact with water or moisture or anything moist from the air.

Q. How does corrosion on the magnesium occur?

A. It would occur because the battery had taken up some water, moisture from the air, or some other manner, because after the battery started acting there was corrosion.

Q. Doctor, tell me how you judge if one of the electropositive electrodes that you looked at was magnesium?

A. By its color and the way it received scratching.

Q. Doctor, is there a terminal connected with the electronegative electrode?

A. Yes, this is a multiple battery. However, it is a multiple cell battery, so that the terminals are only on the exteriors of the outer cells.

Q. Let me rephrase the question then. Is there a terminal connected with one of the electronegative electrodes?

A. Yes, sir.

Q. Doctor, can you ascertain from examination by what process or means that cuprous chloride electronegative electrode was made?

A. No, I cannot with any sort of certainty.

Q. All right, Doctor.

Doctor, can you tell by examination whether the cuprous [fol. 220] chloride electrode contained any carbon?

A. Not by optical examination.

Q. All right, Doctor, thank you. Now let us go off the record, please.

(Discussion off the record.)

Commissioner Lane: Back on the record.

By Mr. Reilly:

Q. Doctor Mantell, would you take Trial Exhibit No. 7 and disassemble it, as best you can, so that I may ask you some questions concerning the structure?

A. (Witness disassembles Trial Exhibit No. 7)

Mr. Reilly: Let the record show that Doctor Mantell has been taking a portion of the battery apart with a penknife.

By Mr. Reilly:

Q. Doctor, can you describe a cell or any portion of the battery?

A. I have here what looks like an individual cell, with what appears to be a magnesium electrode of bibulous material, and a copper screen on which appears a greenish color, and this greenish color I would interpret as cuprous chloride.

Q. Doctor, what is the copper-colored material?

A. The copper-colored material would be the back part of an electrode, contacting the screen on which the cuprous [fol. 221] chloride is.

Also there appears to be a resinous or plastic material, and I can't determine whether that is just the outer boundary of the cell or whether it has any relation to the bibulous material.

Q. Just describe, if you can, Doctor, in terms of color, and so forth, what we are talking about there.

A. The magnesium electrode is a silvery gray, and adjacent to the magnesium electrode is bibulous material. There seems to be a piece of black string in the center of the bibulous material.

Then on the other side there is cuprous chloride backed up by copper.

Q. Doctor, first, do you have a battery in front of you?

A. In the conventional sense, it is more than one cell, it is a battery.

Q. Does the battery have a liquid container?

A. It has a liquid container in the form of the bibulous material.

Q. Did you find a magnesium electropositive electrode present?

A. I did.

Q. Is it inside the container?

[fol. 222] A. It is inside the container, and one face is adjacent to the container.

Q. Does the electropositive electrode, or one of them have an external terminal?

A. In this one only one, and the others have individual terminals, and so with reference to the individual cells they do not have individual terminals except as they contact each other in series to make the equivalent of terminals.

Q. In the battery is there an external terminal?

A. In the battery as a whole there are external terminals.

Q. And they are connected to the electropositive electrode?

A. One is connected to the electropositive electrode, and the other to the electronegative electrode. There are various combinations here, various groupings in this battery.

Q. Did you find there was also present a cuprous chloride electronegative electrode?

A. I did, and again that conclusion is as the result of the color of the material which resulted from the battery.

Mr. Reilly: Let the record show that Doctor Mantell has a small pile of broken bits of this green material in front of him.

[fol. 223] By Mr. Reilly:

Q. Doctor, can you tell by any examination which you can reasonably perform here, whether that material contains copper?

A. No, I cannot, with any degree of surety.

Q. Doctor, can you form any opinion as to the process by which the cuprous chloride electrode was made?

A. It appears to be an operation which brought the cuprous chloride into the form of a paste, and then put on a screen, and the screen appears to be a metallic copper screen.

Q. Will you pass it up to His Honor?

A. Yes, sir.

(Witness complies)

Q. Doctor, can you tell us if there are any resins in that at all?

A. No, sir.

Q. I have already asked you, have I not, if there was carbon present, and you testified that there was?

A. I can't tell you.

Q. Let us go ahead and look at the other battery, the remaining physical sample, which is Trial Exhibit No. 9, and see if anything can be learned from an examination of it.

A. (Disassembling and examining Trial Exhibit No. 9) [fol. 224] This appears to be a battery with a magnesium electrode, a bibulous material, a flat mass of what appears to be cuprous chloride, on what appears to be copper foil. I have separated the cuprous chloride from the copper foil, but the copper foil and the cuprous chloride were one mass at one time. In other words, the cuprous chloride and the copper were affixed together as one mass of material.

Q. Doctor, let me run down through the claim elements again. Is it a battery?

A. It is a battery.

Q. Does the battery have a liquid container?

A. The individual cells have a liquid container.

Q. Is there a magnesium electropositive electrode?

A. Yes.

Q. Is that magnesium electrode inside the liquid container?

A. Yes.

Q. Does the magnesium electropositive electrode, or any of the magnesium electropositive electrodes have an exterior terminal?

A. Inasmuch as this is a multiple battery, it would appear that the answer is "yes."

Q. Can you say that, Doctor?

A. Yes, here it is (indicating).

[fol. 225] Here are the terminals here (indicating).

Q. Will you describe what you are pointing to, Doctor?

A. I am pointing to two pieces of metal which appear to be copper, and they are at the top of the battery, as it were, standing on its bottom, and there are two terminals, and one goes to one side of the battery and the other goes to the other side of the battery, and the individual cells being arranged vertically and compressed together, so one is on a magnesium terminal and the other is on a copper terminal.

Q. Is there a cuprous chloride electronegative electrode?

A. In my opinion, just from the greenish coloration, yes.

Q. Can you tell anything about the process by which the cuprous chloride electrode might have been made?

A. Not positively.

Q. Does it appear to be as strong as the cuprous chloride electrode which you were looking at in the preceding battery, which was Trial Exhibit No. 7?

A. No, it does not appear to be quite as strong as the cuprous chloride in the preceding battery.

Q. Can you tell, Doctor, if there is any carbon in the cuprous chloride electrode of Trial Exhibit No. 9?

A. No, not by simple examination.

[fol. 226] Q. All right, Doctor, thank you.

Doctor, do you have a copy of Trial Exhibit No. 1?

A. No, sir.

Q. Here is a copy.

A. Thank you.

Mr. Reilly: Do you have a copy, Your Honor?

Commissioner Lane: Yes, sir.

By Mr. Reilly:

Q. Referring to a portion of Trial Exhibit No. 1, Doctor, being the Eagle-Picher letter—Mr. Arseneau produced this material, and do I designate it correctly when I say it is an Eagle-Picher letter of four pages, dated November 29,

1960, which is indicated only on the second and fourth pages of the letter, and signed by a Mr. M. F. Chubb?

Commissioner Lane: I think it would be correctly designated as portions of four pages.

Mr. Reilly: That is better. Thank you, Your Honor.

By Mr. Reilly:

Q. Referring to that portion of Trial Exhibit No. 1, Doctor, would you please read the first sentence of the first paragraph that is not blocked out on the first page?

A. (Reading) "All magnesium/cuprous chloride batteries which have been produced by Eagle-Picher have been made in accordance with the process outlined in Fischbach Patent [fol 227] No. 2,636,060 and/or Chubb Patent No. RE23,883. These essentially contain . . ."

Q. Just the first sentence, Doctor.

Doctor, I show you once again Trial Exhibit No. 7, and ask you if you can read the designation on one side of the battery, the entire designation?

A. (Reading) "Battery pack BA-259/AM Order No. The Eagle-Picher Company."

Q. Doctor, would you explain whether the instructions that are given on a portion of the top of the surface of the battery which is designated "Top"?

A. (Reading)

"Caution: During activation and operation this face must be on top or battery will not function.

"(1) Spring box open at arrow A, and place battery on level surface.

"(2) Insert funnel at opening A."

That is a hole opposite the arrow designated by "A."

(Continuing reading) "(3) Fill slowly through funnel with water until it spills from overflow hole marked B."

"B" is at the end of the battery closest to me and at 90 degrees from A clockwise.

(Continuing reading) "(4) Allow water to remain [fol. 228] in box for approximately 3 minutes.

"(5) Remove tape from drain holes on bottom of battery and allow battery to drain."

There are drain holes in the lower corners, in the area of the same side as opening B, and at 90 degrees clockwise from A.

(Continuing reading) "(6) Shake battery vigorously up and down for 1 minute to remove excess water through drain holes.

"(7) Connect battery to using equipment so that normal current load is placed on battery, and discharge for 25 minutes. Battery is now ready for use."

Q. Thank you, Doctor.

Referring please to Trial Exhibit No. 2, Doctor, the Fischbach patent, do you have a copy of the Fischbach patent, Doctor?

A. I do.

Q. Now, Doctor, referring to column 1, lines 5 to 7, what does Fischbach state that his invention relates to?

A. It relates to primary cells of the deferred action type, using the electro-chemical system magnesium-water-cuprous chloride.

Q. What else have we covered so far which disclosed [fol. 229] the electrochemical system magnesium-water-cuprous chloride?

A. That is the same system as the Adams patent.

Q. Doctor, just to have it on the record, what United States patents were cited against the Fischbach patent?

A. Adams alone of the United States patents.

Q. Referring to lines 8 to 18 of Trial Exhibit No. 2, in column 1, what does Doctor Fischbach state?

A. He states:

"Magnesium-cuprous chloride batteries have attained considerable importance, particularly as 'meteorlogical' or 'one-shot' batteries, ..."

Meaning one-time use—

". . . due to their high capacity per unit of weight and volume, their excellent operating characteristics even at low temperatures (linear potential and capac-

ity), their ease of activation with water as electrolyte and their low cost of manufacture. Since neither acid nor alkaline electrolytes are used in these batteries, the danger of corrosion, caused . . . ."

and the "d" is missing—

". . . particularly by acid fumes, is completely eliminated."

Q. Does that sound familiar to you?

[fol. 230] A. It sounds extremely familiar. It is almost Adams' words in his patent.

Q. Doctor, referring to column 1, lines 19 to 25, what is there described?

A. (Reading) "In the past, cuprous chloride electrodes were made from fused cuprous chloride. In manufacturing such cuprous chloride electrodes a supporting structure, for instance, a coil or a wire grid, was placed in a mold and the latter supplied with the requisite amount of fused cuprous chloride poured from a heated crucible. It has also been known to dip a screen wire base into a fused mass of cuprous chloride in order to produce an adherent film on the screen. Fused cuprous chloride involves a number of severe production difficulties, particularly in mass production, due to the necessity of maintaining the cuprous chloride at relatively high temperatures while charging the supporting grids or plates with the fused cuprous chloride. In addition to these production difficulties, the active area of a fused cuprous chloride electrode is limited substantially to the outer surface exposed to the electrolyte while the interior parts of the fused cuprous chloride remain mostly inactive."

[fol. 231] Q. All right, Doctor.

In lines 19 to 25, just those lines, Doctor,—will you just review them to yourself?

A. Yes, sir.

(Witness complies)

Q. What does Fischbach describe?

A. He describes, but in words different from those used by others, the melting, liquefaction, solidification and unification of a cuprous chloride electrode made by heat.

Q. Where have you seen this specific operation described before?

A. It is described in the Adams patent.

Q. Now, Doctor, referring only to the next three lines, which I will read to you:

> "It has also been known to dip a screen wire base into a fused mass of cuprous chloride in order to produce an adherent film on the screen."

What is he describing there?

A. He is describing the production of a unified, melted and cooled cuprous chloride on a screen, to make a cuprous chloride electrode.

Q. Doctor, in line 27 of the patent which you have just read, with relationship to the preceding lines up to and including line 19, how, if you can tell, did Doctor Fischbach [fol. 232] use the word "fused," and what does he mean by it?

A. In his terminology, by the use of the word "fused" he means melted or cast, and mostly he is using the word "fused" as melted, but he also refers to the product as "fused cuprous chloride" because he uses it in two different ways. In line 24 it shows "fused cuprous chloride poured from a heated crucible," and he means "melted."

Q. Do you mean melted by heat?

A. Melted by heat. In lines 26, 27 and 28, he says: "fused cuprous chloride," and by that it would appear that he means the final product instead of using the words "fusing cuprous chloride."

Q. Doctor, have you used the method described in the Fischbach patent in lines 25 through 28?

A. Yes, we have made cuprous chloride electrodes on copper screens by melting the cuprous chloride and dipping the copper screen in and allowing it to cool, and obtaining a composite structure.

Q. How did it work?

A. We had no difficulty.

Q. Doctor, did you bring any samples with you?

A. Yes, sir.

Q. Will you produce them, please?

A. Yes, sir.

[fol. 233] Q. What have you got in your hand, Doctor?

A. I have here some screens.

Q. Doctor, don't disassemble them but just tell me what you have got.

A. I have sheets of paper on the inside of each one, and it is a copper screen, with the weight of the copper screen and the screen after the cuprous chloride has been added.

Mr. Reilly: Thank you. I would like to pass that around for the information of the Commissioner and Mr. Arseneau. (Exhibiting same)

Your Honor, I would like to introduce these electrodes as Plaintiffs' Exhibits Nos. 22 through 25.

Mr. Arseneau: Are these being offered for identification at this time, without further comment?

Commissioner Lane: They will be marked for identification at this time.

Mr. Arseneau: I understand now.

(Four sheets of paper to which was attached copper screens, showing respectively weight of 2.7 grams, 3.85 grams, 3.7 grams and 2.9 grams were marked respectively Plaintiffs' Exhibits Nos. 22, 23, 24 and 25 for identification.)

By Mr. Reilly:

Q. Doctor, did you make those electrodes?

A. Yes.

[fol. 234] OFFERS IN EVIDENCE

Mr. Reilly: Then I will offer them, Your Honor. Is there any objection?

Mr. Arseneau: No objection.

Commissioner Lane: For what purpose are they being offered?

Mr. Reilly: Your Honor, I will connect it up with the testimony which is to be adduced through the witness, and we will introduce them to show that there is no special difficulty, and Doctor Mantell will so testify, in making these things by simple methods which he will testify to in the next few moments.

Commissioner Lane: They will be received in evidence.

(The exhibits heretofore marked for identification Plaintiffs' Exhibits Nos. 22, 23, 24 and 25, were received in evidence.)

By Mr. Reilly:

Q. Doctor, referring to these exhibits which have been marked Plaintiffs' Exhibits Nos. 22 through 25, will you tell the Court just how those were made?

A. These were made by passing copper screen through cuprous chloride, liquefied by heat. We found that we could get the weight that we might want on the copper screen by very careful control of the cuprous chloride temperature and the temperature of the screen. If the screen were [fol. 235] allowed to reach the temperature of the liquid cuprous chloride, we would obtain thin films. If we dipped the screen in the liquid cuprous chloride as rapidly as possible, so that the screen would not reach the temperature of the liquid cuprous chloride, we could make thicker layers. If we wanted to make still thicker layers, we could re-dip, following the same principles, with a cold screen and a rapid motion, and make them thicker.

This is well known because it is the kind of practice that is involved in hot tinplate manufacture and galvanizing manufacture, and in many metal-dipping operations, and in the tinning operations, and the factors which we have referred to have been completely and widely known in the metal-coating art for a very long time.

Q. Doctor, what equipment would you use to heat up the cuprous chloride?

A. We used a porcelain vessel, relatively shallow and large in diameter, which we heated over a laboratory burner.

Q. A Bunsen burner?

A. It was not a Bunsen burner but was an improved type of Bunsen burner.

Q. Then what was the next step?

A. The copper screen was picked up with a pair of [fol. 236] tweezers or tongs, and caused to be dipped into the molten cuprous chloride.

Q. You did this by hand?

A. We did this by hand.

Q. Do those electrodes have a degree of flexibility?

A. They have an appreciable degree of flexibility. They cannot be bent to any degree sharply but they can be rolled without cracking.

Q. Is there anything else in there besides cuprous chloride?

A. These contain two per cent carbon, but we have others which were made in the same way without the carbon.

Q. There was no binder or resin in this?

A. No binder or no resin.

Q. Doctor, in lines 28 to 39, column 1, without reading it in detail, what does Doctor Fischbach say about making cuprous chloride electrodes by dipping a wire screen base into a heated, liquefied mass of cuprous chloride?

A. He says that it "involves a number of severe production difficulties. . . ."

Q. What else does he say about it?

A. (Reading) ". . . due to the necessity of maintaining the cuprous chloride at relatively high temperatures while charging the supporting grids or plates with the fused [fol. 237] cuprous chloride."

Q. We have covered that. We have gone to another subject and let's go ahead with it.

A. It says:

> ". . . the active area of a fused cuprous chloride electrode is limited substantially to the outer surface exposed to the electrolyte while the interior parts of the fused cuprous chloride remain mostly inactive."

Q. What does he mean by that?

A. I can only assume that he means the outer surface is so fine and non-porous that it acts as if it were a solid material.

Q. Do you find those cathodes non-porous?

A. I do not find those cathodes non-porous.

Q. Does Doctor Fischbach say anywhere in his patent, Trial Exhibit No. 2, that the cathodes which he describes in column 1, lines 19 through 25, or 25 through 28, would not work?

A. He does not.

Q. Doctor, concerning Doctor Fischbach's observation,

which you have mentioned, with respect to severe production difficulties, what do you have to say concerning that?

A. In my opinion, this is merely someone presenting [fol. 238] his own pet baby because the same severe production difficulties could be met in tinning, in coating, in painting, in making layers, in laminations, none of which have production difficulties, whether they be foil or whether they be thick metal or whether they be thin, or whether they be high-temperature operation or low-temperature operation.

Q. Doctor, when you heat this cuprous chloride substance, do you need any special equipment to do it, when doing it on a large scale?

A. The material has some toxicity, and you need a good ventilating system, but you need good ventilating systems in every metal-contacting operation, where you have flux, and the flux may have a degree of toxicity.

Q. Doctor, in lines 35 to 51, column 1, Trial Exhibit No. 2, what does he say that the object of his invention is, and how does he achieve the object?

A. He wanted to produce a cuprous chloride electrode "which is of a porous or spongy character." He also wanted "to facilitate manufacturing methods and to obviate the necessity of heating the cuprous chloride to the fused condition."

That is melting it.

Q. What does he say in the next few lines that he desired? What is his method?

[fol. 239] A. In his method he makes "a pasty mixture comprising essentially finely ground cuprous chloride and a liquid, essentially water. The cuprous chloride is not brought into the fused condition, and heat, if any, is applied only to accelerate the drying process."

Q. Just what is done, Doctor?

A. He liquefied the cuprous chloride by water.

Q. Does he grind it up? Where does he say that?

A. He says makes "a pasty mixture."

Q. I see.

Doctor, has there been any criticism of the electrodes made by the method described in lines 47 to 55 of Fischbach?

A. Yes, there has been, by other manufacturers.

Q. Doctor, are you referring to Mr. Melvin F. Chubb's patent?

A. I refer to the Chubb Reissue Patent No. 23,883.

Mr. Reilly: That is Trial Exhibit No. 6, Your Honor.

By Mr. Reilly:

Q. Does that patent criticize the electrodes?

A. That patent first says that it has some of the same things that Fischbach said about the fused cuprous chloride with respect to production difficulty.

Q. What do you mean when you say "fused"?

[fol. 240] A. I am referring to the terminology used by Chubb and he is using the same terminology as Fischbach.

Q. Which means what?

A. Melted.

Q. By the heating process?

A. By the heating process. He says:

"These insufficiencies have been overcome—"

Q. Doctor, what I want to get at here, just to move along, is that I want to get at the part where he is discussing it in relation to the Adams electrode.

A. That is what I am coming to.

Q. All right.

A. (Reading) "These insufficiencies have been overcome by the development of a porous cuprous chloride electrode made from a pasty mixture comprising, essentially finely ground cuprous chloride and a liquid, substantially water."

Those are Fischbach's words.

(Continuing reading) "This mixture is pasted on the supporting structure or grid, e.g., a wire screen of copper, and the electrode is then dried at room or elevated temperature. The resulting porous cuprous chloride electrodes still present a number of practical difficulties. One of these [fol. 241] difficulties consists in insufficient adhesion of the paste to the supporting grid, another lies in the great reactivity of cuprous chloride of high porosity. Insufficient adhesion results in electrodes of low physical strength having a tendency to deteriorate mechanically, while the high reactivity of porous cuprous chloride electrodes leads to

overheating of the cells, particularly in case of high voltage batteries and prolonged discharge periods."

Then Chubb comes along and he has a method of his own, and he thinks his baby is prettier than the other two.

Q. Doctor, in the statement which you have read, I note the part where he says:

> ". . . while the high reactivity of porous cuprous chloride electrodes leads to overheating of the cells, . . ."

Is he there referring to the melted-by-water electrodes or the melted-by-heat electrodes?

A. He is referring to the melted-by-water electrodes.

Q. Are those the ones of the Fischbach invention?

A. Yes.

Q. Doctor, do you believe Mr. Chubb's remarks which you have just stated concerning the problems involved in the electrodes made by melting with water, and do you [fol. 242] believe they are justified?

A. They are justified to a degree, but the justification is a comparative justification of the method which Chubb now proposes.

Q. I see. Doctor, did you find any difficulty mentioned in the Fischbach patent with regard to maintaining the cuprous chloride at temperatures sufficient to keep it liquid?

A. None at all.

Q. What is the melting point of cuprous chloride?

A. 422° Centigrade.

Q. Is that a relatively high temperature in production processes?

A. It is a relatively low temperature in production processes.

Q. Doctor, will you describe for me the process of continuous galvanizing on steel with zinc?

A. In continuous galvanizing on steel with zinc, it is done by the hot-dipping process, and a dried sheet is passed through a layer of flux, generally zinc chloride or zinc chloride and ammonia chloride, and then from a layer of flux into a bed of molten zinc. That is done either by hand or it is done on a continuous strip.

[fol. 243] Then the sheet is withdrawn and cooled, and there may be rollers or wipers used to remove any flux, and

then the sheets are either cast in coils or they may be cut and formed into plates after cooling.

Q. What is the temperature that the molten zinc is maintained in?

A. I don't remember exactly, and I would have to look at something, but it is of the order above the melting point of cuprous chloride.

Q. Do you know the rate of passage of the steel sheet through the zinc in commercial production, and how many feet per minutes goes through or the dimensions of the steel sheet?

A. It varies with the size of the installation, but in small specialized cases it may be a few feet a minute up to several hundred feet a minute, and in one or two cases higher than that.

Q. How wide is the strip which you are talking about?

A. From two inches wide to 36 to 40 inches.

Q. Do you have any information on the speed where they run such a strip through?

A. It is closer to six or seven hundred feet a minute.

Q. When the material passes through, is it coated with zinc by this process?

A. It is coated with zinc.

[fol. 244] Q. Broadly, how does Doctor Fischbach make his cuprous chloride electrode? You can read his patent to yourself without reading it into the record.

A. He makes it by taking finely ground cuprous chloride and a liquid, such as water, and makes it into a paste. He may add various conductive materials which he says are inert, such as carbon black, graphite, Dixon black and Shawinigan black, and perhaps mixing graphite in amounts of the order of one to two per cent of the cuprous chloride.

Q. Doctor, are all those substances one thing which you named?

A. No, they are different things, but they are all carbon, and in that sense they are all one thing. He takes the cuprous chloride mixture and pastes it on the wire screen and air-dries it at room temperature, or dries it at elevated temperatures.

Q. What is the object of the addition of water to the finely ground powder?

A. It is in effect to aid in the blending of the cuprous

chloride and the carbon and to liquefy the material, making it so that it can be applied to the copper screen, and after drying, obtaining a unified structure.

Q. Doctor, how well does the mix which you have just described as being applied to the screen after drying adhere [fol. 245] to the screen?

A. Quite well.

Q. The dried mix adheres well to the screen?

A. Yes, we have made such.

Q. Would you produce some of the ones you have made, Doctor?

A. Yes, sir.

Commissioner Lane: When you reach a good stopping point, we will adjourn for the day.

Mr. Reilly: Do you want to have him bring that out now or do you want to recess?

Commissioner Lane: We will recess until tomorrow morning at 10:00 o'clock.

Mr. Reilly: Thank you.

(Whereupon, at 4:30 o'clock p.m., Tuesday, July 11, 1961, the trial of the above-entitled cause was adjourned, to reconvene at 10:00 o'clock a.m., Wednesday, July 12, 1961.)

[fol. 246] **Transcript of Testimony for Plaintiffs (Resumed)—July 12, 1961**

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[fol. 247] Commissioner Lane: You may continue, Mr. Reilly, when you are ready.

Mr. Reilly: Thank you, Your Honor.

Whereupon CHARLES L. MANTELL, the witness on the stand at the taking of the recess, resumed the stand and testified further on behalf of the Plaintiffs, as follows:

Direct examination (Resumed)

Mr. Reilly: This morning I wanted to clear up one thing on the record, if I may. Yesterday when Doctor Mantell was testifying he took one of the electrodes, where the cuprous chloride was unified to the grid by a heat process, which was Plaintiffs' Exhibit No. 24, and while he was speaking he rolled it into a circle, and I would like to have the record show that.

By Mr. Reilly:

Q. Doctor, have you made electrodes with cuprous chloride liquefied by water?

A. I have.

Q. Do you have any of them with you, Doctor?

A. Yes, sir. (Producing objects)

Q. Doctor, describe these objects which you have just placed upon the table, if you will.

[fol. 248] A. These are wire screen, copper wire, of the same character as used in Plaintiffs' Exhibits Nos. 22 to 25, and cuprous chloride has been liquefied with water and then placed on the same type of screens by a spatula and allowed to dry.

Q. Did you make these, Doctor?

A. I made these.

Mr. Reilly: I will pass these around so that they can be seen.

(Exhibiting objects)

By Mr. Reilly:

Q. Doctor, do these contain carbon?

A. These do not contain carbon.

Q. Do you have any which you have made which contain carbon?

A. Yes, sir, I do.

(Producing objects)

Q. Doctor, before you proceed let me get these identified.

OFFERS IN EVIDENCE

Commissioner Lane: The first one will be Plaintiffs' Exhibit No. 26.

Mr. Reilly: I will ask that these be marked and received in evidence as Plaintiffs' Exhibits Nos. 26, 27, 28 and 29.

Commissioner Lane: These are marked "Cuprous Chloride Pasted Type"?

The Witness: Yes, sir.

[fol. 249] By Mr. Reilly:

Q. Will you describe what they consist of?

A. They consist of cuprous chloride liquefied by water and spread on a screen and then allowed to dry.

Commissioner Lane: Did you do this?

The Witness: Yes, sir.

By Mr. Reilly:

Q. Are these copper screens any different than the copper screens used in Plaintiffs' Exhibits Nos. 22 to 25?

A. It is identical and made from the same piece.

Q. And is the cuprous chloride the same?

A. Yes, sir, from the same bottle.

Q. Doctor, you have four objects on the table in front of you, and will you tell the Court what they are, please?

A. These are electrodes which are made from a paste consisting of 100 parts cuprous chloride and 30 parts of water and two per cent carbon, on the same type of cuprous chloride, and as with the others, the materials are liquefied and the paste spread on the screen, and then the materials allowed to dry.

Plaintiffs' Exhibits Nos. 26 through 29 were of the same proportion of water and cuprous chloride.

Q. Doctor, did you make these four objects on the desk in front of you yourself?

[fol. 250] A. Yes, sir.

Mr. Reilly: I will ask that they be identified and received in evidence as Plaintiffs' Exhibits Nos. 30, 31, 32 and 33.

Commissioner Lane: Does Defendant have any objection?

Mr. Arseneau: No objection, Your Honor.

Commissioner Lane: Plaintiffs' Exhibits Nos. 26 through 29 will be received in evidence.

(Sheets headed "CuCL Pasted Type, with weight of paste 3.1 grams, 2.9 grams, 3.0 grams and 3.4 grams," respectively, were received in evidence as Plaintiffs' Exhibits Nos. 26, 27, 28 and 29.)

Commissioner Lane: Plaintiffs' Exhibits Nos. 30 through 33 will be received in evidence.

(Sheet headed "CuCL Pasted Type, with screen attached, showing weight of paste 3.8 grams," was received in evidence as Plaintiffs' Exhibit No. 30.)

(Sheet headed "CuCL Pasted Type, with screen attached, showing weight of paste 3.5 grams," was received in evidence as Plaintiffs' Exhibit No. 31.)

(Sheet headed "CuCL Pasted Type, with screen attached, showing weight of paste 3.4 grams," was received in evidence as Plaintiffs' Exhibit No. 32.)

[fol. 251] (Sheet headed "CuCL Pasted Type, with screen attached, showing weight of paste 3.6 grams," was received as Plaintiffs' Exhibit No. 33.)

By Mr. Reilly:

Q. Doctor, while these are being inspected, would you take the electrode which is Plaintiffs' Exhibit No. 33 and tell us what its flexibility is?

A. Its flexibility is reasonably good, although in bending it to form a complete circle I have bounced some of the material off, as shown on this sheet here. (Indicating)

Mr. Reilly: I will hand that electrode to the Court for inspection. (Handing object to Commissioner)

Commissioner Lane: All right. (Examining and handing back to counsel for Plaintiffs)

Mr. Reilly: Thank you, Your Honor.

By Mr. Reilly:

Q. Doctor, how long did it take to liquefy by heat cuprous chloride to make one of these electrodes?

A. Of the order of ten minutes or less.

Q. How long after you have liquefied the cuprous chloride does it take to make an electrode out of it?

A. One to two minutes.

Q. Doctor, when you make an electrode out of cuprous chloride which has been liquefied with water, how long does [fol. 252] it take to dry the electrode before it is serviceable?

A. If it be air-dried, of the order of six to eight hours, and if it be put in a drier and dried at 100 to 110 degrees Centigrade, one to two hours.

Q. Doctor, let me digress for just a second.

Will you point out in the Fischbach patent, Trial Exhibit No. 2, something for me? I will ask you to refer to column 2, lines 53 to 55, and will you relate the part of the description which I indicated? What is found concerning the anode in the Fischbach construction, and by that I mean what material is it made of?

A. Column 2, line 53?

Q 53 or 54, yes, sir.

A. (Reading) "The magnesium electrode 1 is preferably of about .006"-0.014" in thickness."

It is made of either pure magnesium or some alloy.

Q. Doctor, in the Fishchbach patent what is the subject matter of the patent?

A. Primary cells, of the deferred action type, using the electro-chemical system magnesium-water-cuprous chloride.

Q. Is a battery disclosed in the Fischbach patent?

A. Yes.

Q. Does the battery have a container?

A. Yes.

[fol. 253] Q. Can you point out the part of the patent where the container is identified?

A. The container is identified as "a spacer 3 consisting, in conventional manner of any suitable, bibulous and ionically conducting material separates the magnesium electrode 1 from the cuprous chloride electrode 2."

Q. Thank you.

Does the Fischbach battery have a magnesium electropositive electrode?

A. Yes.

Q. Is that electrode inside the container?

A. Yes.

Q. Does the magnesium electrode, or one of them, have an exterior terminal?

A. Yes.

Q. Does the battery have a cuprous chloride electronegative electrode?

A. Yes.

Q. Does one of the cuprous chloride electronegative electrodes have a terminal connected to it?

A. Yes, sir.

Q. Doctor, once again briefly, how is the cuprous chloride electrode manufactured?

A. It was made by the mixture of 100 grams of cuprous [fol. 254] chloride to 30 grams of water, and that is made into a paste and liquefied, and from then it was pasted onto a grid, consisting of "a wire screen of copper" or other suitable material, and after this blending operation, it is allowed to dry.

Q. Doctor, does the Fichbach patent, Trial Exhibit No. 2, provide for carbon to be added?

A. It does, and particularly substances such as graphite and Shawinigan black may be added to the extent of one or two per cent. These are carbons.

Q. Doctor, what is the simplest and quickest type of cell which you know how to make?

A. What?

Q. The simplest and quickest type of cell which you know how to make of the magnesium-cuprous chloride-water-activated system?

A. The simplest would be a sheet of magnesium and

cuprous chloride with electrode spacer in between and electrical connections.

Q. Doctor, would you take one of the electrodes, Plaintiffs' Exhibits Nos. 22 to 25, which are the cuprous chloride electrodes with carbon, liquefied by heat and solidified, and make such a battery out of it, please?

A. Yes, sir. I am taking Plaintiffs' Exhibit No. 25 and [fol. 255] taking a sheet of Kleenex tissue and wrapping that around the Kleenex to serve as the bibulous or the absorbent material. So much for that electrode.

For the other electrode I have a piece of magnesium which has been cut from sheet magnesium, and then bent. In order to get the electrical connection out of the cuprous chloride, you must bend it out of the way. It has a stove bolt as a method of fastening.

Mr. Reilly: I will identify one of the pieces of magnesium that the Doctor has just discussed.

The Witness: Because the Kleenex is longer than the electrode, I have to cut it off. The copper screen has a hole already punched in it and I propose to put a bolt in for an electrical connection. I am now inserting the bolt through the copper screen.

(Demonstrating.)

Then I will insert the copper screen inside the bent magnesium, and in order to bring them closer together I am flattening out the magnesium.

(Demonstrating)

I have wrapped around the assembly a piece of Scotch tape.

(Demonstrating)

I have already electrically connected to the magnesium [fol. 256] one wire, which goes to the base of a small lamp, and I am now connecting the other wire to the copper screen, so now the lamp is the load on the battery, and the battery is now ready for water immersion.

By Mr. Reilly:

Q. Doctor, shall we ask someone to get a beaker of tap water, or whatever you want to drop it in?

A. Any sort of water will do.

Q. Doctor, can you estimate how long it took you to make the battery, together with the connection to the electric light?

A. I will estimate that if I started it, having to make all the electrical connections, it would take five minutes or less.

Q. What did you use as the bibulous material?

A. Kleenex tissue.

Q. What did you wrap around the battery to keep it together?

A. Scotch tape.

Q. Here is the water, Doctor. (Handing water to the witness.)

A. You can use fresh water or salt water.

Q. If the electrical connection is all right, it is not broken, is it?

[fol. 257] A. That is correct.

Q. Doctor, does this take a while to get started?

A. Yes, sir.

Q. While we are waiting, just looking at the battery which you have put together there, does it contain a liquid container?

A. Yes, sir.

Q. Even when you connected it with the container?

A. Yes, sir.

Q. Does it have a magnesium electropositive electrode?

A. Yes.

Q. Is the electrode inside the container?

A. Yes, and when it is removed from the water the bibulous material becomes the container and the magnesium accomplishes this.

Q. Does the magnesium electrode have an exterior terminal?

A. Yes, sir.

Q. Is there a cuprous chloride electronegative electrode in the battery?

A. Yes, sir.

Q. Does the electrode have a terminal?

A. Yes, sir.

Q. What was the process, again, by which you made [fol. 258] the cuprous chloride and the grid?

A. In this particular case, this cuprous chloride was made by blending, melting and solidification.

Commissioner Lane: I note the activation time was 70 seconds.

Mr. Reilly: The activation time was 70 seconds and the battery began to operate at approximately 10:28 in the morning of Wednesday, July 12th.

By Mr. Reilly:

Q. Now, Doctor, referring to the Fishbach patent—and I will put this exhibit some convenient place——

Mr. Arseneau: What Plaintiffs' exhibit did you use?

Mr. Reilly: Plaintiffs' Exhibit No. 25.

By Mr. Reilly:

Q. Now, Doctor, referring once again to the Fischbach patent, does that patent teach the addition of any salts to the water in the cell? I am referring to column 3, lines 29 to 37.

A. It teaches that chlorides, particularly sodium chloride, may be added, or hydrochloric acid and related compounds, which are ionizable substances, may be added.

Q. Doctor, where else have we seen this teaching of adding salts?

A. In Adams, his addition of magnesium chloride.

[fol. 259] Q. Doctor, before I go on to the Chubb patent, we used Plaintiffs' Exhibit No. 25 as an electrode to make up the demonstration battery. Would you see if there is any electrode from amongst the group of electrodes made with cuprous chloride and carbon, liquefied by water, that are in any way close to the weight of the active material in Plaintiffs' Exhibit No. 25?

Let me note on the record at this time that these were picked at random, and I don't know whether there is anything close or not, and I have no intention of making a comparative test here as to relative efficiency. There will

be some comparison made but it is not to prove any operative difference between them.

A. Plaintiffs' Exhibit No. 25 shows a weight of cuprous chloride and carbon of 2.9 grams, and this shows 2.9 grams of cuprous chloride.

Q. What is "this"?

A. Plaintiffs' Exhibit No. 27.

Q. That is without carbon, Doctor. Do we have anything with carbon which is close?

A. These are a little heavier, 3.5 grams (indicating).

Q. Doctor, you have selected an electrode of the type made with cuprous chloride and carbon, liquefied by water. Which exhibit is that, please?

[fol. 260] A. Plaintiffs' Exhibit No. 31.

Q. Plaintiffs' Exhibit No. 31?

A. Yes, sir.

Q. What is the weight, Doctor, of the cuprous chloride and the carbon?

A. 3.5 grams.

Q. What was the weight of the cuprous chloride and carbon in Plaintiffs' Exhibit No. 25?

A. 2.9 grams.

Q. Doctor, will you make a battery of the electrode shown in Plaintiffs' Exhibit No. 31, please?

A. I will make the battery in the same way, taking the cuprous chloride electrode and wrapping it with Kleenex, taking off the excess Kleenex, as was done before, and inserting the cuprous chloride electrode in the magnesium, to which I already have an electrical contact (indicating). I am now inserting a stove bolt for electrical contact to the copper wire screen. (Demonstrating)

I have now squeezed the magnesium, as I did before, with a pair of pliers, and I have wrapped the cell with Scotch tape, and now with one electrical connection made to the magnesium, I will attach the electrical connection to the copper screen, and again——

Commissioner Lane: May I see it before you go further, [fol. 261] please?

The Witness: Yes, sir. (Handing same to Commissioner)

Commissioner Lane: (Examining) All right.

Mr. Reilly: Show it to Mr. Arseneau, please, so that he may examine it.

The Witness: Yes, sir.

Mr. Arseneau: (Examining demonstration object) Thank you very much.

The Witness: With the same reservations as stated before as to the external circuit and the type of contacts, and with the lamp in good condition, I should be able to dunk it.

By Mr. Reilly:

Q. Go ahead.

A. (Demonstrating) I have now put the assembled battery with the lamp in a beaker of water.

Q. What was the approximate time?

Commissioner Lane: 25 seconds.

Mr. Reilly: 25 seconds. Let the record show that the battery activated in 25 seconds.

By Mr. Reilly:

Q. Doctor, will you take this battery and put it up next to the other battery?

A. Yes, sir. (Witness complies)

[fol. 262] Q. I think we better put a tag on to show which is which, because after the whole thing is over you can't distinguish them.

The one on the left is the last one, is it not?

A. The one on the left is the last one.

Mr. Reilly: All right, I will put a tag on it. What time did it go on? About 22 minutes until eleven?

Commissioner Lane: Yes, sir.

Mr. Reilly: Let the record show that the second battery constructed by the Doctor activated at about 10:38.

Mr. Arseneau: 10:39.

Mr. Reilly: The gentlemen at Defendant's counsel table have advised that it was 10:39. I will mark this one and the other one.

Let the record show that the two pieces of paper which were attached to Plaintiffs' Exhibits Nos. 25 and 31 shall remain in the record, giving the weights of materials and so forth. They are not too important, but they are there.

By Mr. Reilly:

Q. Now, Doctor, would you refer to the Chubb patent?
A. Yes, sir.

Mr. Reilly: For purposes of keeping the record clear, that is Trial Exhibit No. 6, and the reason I am referring to it again is because it is also mentioned in the Eagle-[fol. 263] Picher letter, the first sentence.

The Witness: What number?

Mr. Reilly: I'm sorry, Doctor. I mean the Resissue Patent No. 23,883, which is Trial Exhibit No. 6. I have copies of it, Doctor. This is the entire trial exhibit, with the patents attached to it. (Handing document to the witness)

Commissioner Lane: If one of the lights go out, somebody should call attention to it.

Mr. Reilly: If they go out, it is because the connection is not tight. One of the difficulties of this kind of demonstration, I will say in fairness, is that the copper screen through which the bolt passes with the nuts is very fine material, and sometimes it gets eaten away so that you have a premature failure due to lack of contact with the wire, when made in this simple fashion. This was done for demonstration purposes.

By Mr. Reilly:

Q. Doctor, referring to column 1 of the Chubb Reissue Patent, Lines 1 to 3, what does this patent relate to?

A. (Reading) "This invention relates to primary cells, of the deferred action type, using the electro-chemical system magnesium-water-cuprous chloride."

[fol. 264] Q. What patents have we covered so far relating to this system?

A. The Adams patent and the Fischbach patent.

Q. I am referring again to column 1, lines 27 to 47 of the Chubb patent. What is the import of that section, column 1, lines 27 to 47?

A. He is talking about pasted cuprous chloride electrodes and their deficiencies, in that they represent some practical difficulties with respect to insufficient adhesion and the great reactivity of cuprous chloride of high porosity.

Q. Doctor, referring to column 1, lines 48 to 55, what is the import of that statement there?

A. He proposes a paste for the purpose of improving the adhesion and diminishing the high reactivity, thus eliminating the danger of overheating, in his words.

Q. Doctor, referring to column 2 of the Chubb patent, line 35, and going over to column 3, approximately to line 7 on the following page, what is the specific teaching as to how this is to be done?

A. His specific teaching is to make a pasty mixture of cuprous chloride and a resinous material, such as polysterene, with a suitable solvent and with an appropriate plasticizer for the polysterene, and "this is admixed in the [fol. 265] proportion of approximately 162 parts of cuprous chloride to 57 parts by weight of polysterene solution, the solution being made up of approximately 209 parts of polysterene, to 375 parts of toluene, 27 parts of benzene, 25 parts of a plasticizer known under the trade name 'Aroclor #5460,' and about 10 parts of a wetting agent."

Q. So that the polysterene enters as a liquid solution, Doctor?

A. It enters as a liquid solution in the solvents.

Q. Doctor, when you mix this together, as he teaches, what is produced?

A. A paste, and the cuprous chloride has been liquefied as a result of making the paste by using polysterene.

Q. Doctor, referring to column 3, lines 21 to 29, does Mr. Chubb teach the use of carbon?

A. He teaches the use of carbon in the sense used there, using the same words there, the same types of carbon as Fischbach did.

Q. Doctor, what does Mr. Chubb do with his mixture?

A. The paste is mixed on a supporting grid, consisting of a wire screen of copper, bronze, or other metals, and then allows the solvent to evaporate, and the resulting evaporation unifies the cuprous chloride.

Q. Doctor, can you estimate how long it takes to make [fol. 266] an electrode by the teaching of this patent?

A. If the paste were already prepared, I would say that the making of the electrote might be two or three minutes. The elimination of the solvent, depending on whether heat

was employed or not, might be several hours, as much as eight hours in air, and if heat were employed, it might be one to two hours.

Q. I have lost the reference, Doctor, but let the record show that there is a statement concerning that made in column 3, lines 35 to 39 of the Chubb patent.

Doctor, is this a slower or a faster way for making a complete electrode from start to finish than the method of liquefying by heat and solidifying by the way described in the patent?

A. It is a slower way.

Q. Doctor, referring to column 1, lines 1 to 15, what does Mr. Chubb say are the advantages of the electro-chemical system magnesium-water-cuprous chloride?

A. He states:

> "Magnesium-cuprous chloride batteries have attained considerable importance, particularly as 'meteorological' or 'one-shot' batteries, due to their high capacity per unit of weight and volume, their excellent operating characteristics even at low temperature (linear [fol. 267] potential and capacity), their ease of activation with water as electrolyte and their low cost of manufacture. Since neither acid nor alkaline electrolytes are used in these batteries, the danger of corrosion, caused particularly by acid fumes is completely eliminated."

Q. Where have you heard this before, Doctor?

A. These are Adams' statements, in his patents, and in his documents, and they are also Fischbach's statements.

Q. Doctor, in the Chubb patent, does he anywhere state that electrodes made with cuprous chloride, liquefied by heat and solidified by the removal of heat, do not work?

A. No.

Q. Does he mention such electrode in his patent?

A. Yes, he does. In column 1, line 16 on, he talks about the same language that Fischbach used.

Q. Doctor, when Mr. Chubb was originally issued the patent, did the disclosure of the specification and the claims contain any constituent now not present?

A. Yes, the constituent was water.

Q. What significance does this have to you, Doctor?

Mr. Arseneau: May it please the Court, I object to the question in so far as it relates——

Mr. Reilly: I will withdraw it. I think you are right.

[fol. 268] By Mr. Reilly:

Q. Doctor, does the specific battery cell, shown and described in the specification of Chubb here, contain the same elements as the specific battery cell shown in the Fischbach drawing and described in the Fischbach specifications?

A. It does.

Q. Dotor, I would like to have you remark or comment, if you will, on differences between those drawing, in Trial Exhibit No. 2 and Trial Exhibit No. 6. I wish you would lay them side by side before you and tell me what you find.

A. Figure 1 of Fischbach is the same drawing, with the same numbers identifying the parts, save that in Chubb's Figure 1 there are designations as to what the parts are opposite the numbers. Otherwise, or other than that, the drawings are identical.

Q. Go ahead.

A. In Figure 2 the drawings are identical, and neither drawing has any lettered designations as to what the parts mean.

Q. Thank you, Doctor.

Will you turn to the first page of each of those? First, who is the attorney of record initially on Trial Exhibit No. 6, the Chubb patent?

[fol. 269] A. It looks like Lawrence Glassman.

Q. And on Trial Exhibit No. 2?

A. On Trial Exhibit No. 2 it is Harry Saragovitz.

Q. Turning to page 1, Doctor, of each of the two patents, Trial Exhibit No. 2 and Trial Exhibit No. 6, I wish you would compare for me column 1, line 3 down through line 18 of Fischbach vs. column 1, lines 1 through 15 of Chubb.

A. Lines 5 to 7 of Fischbach and 1 to 3 of Chubb are identical.

Lines 8 to 18 of Fischbach and lines 4 to 15 of Chubb are identical.

Q. Thank you, Doctor.

Now, Doctor, referring only to the Chubb patent, Trial Exhibit No. 6, and to the drawings, is a battery disclosed in this patent?

A. In Chubb Reissue No. 23,883, yes.

Q. Does this battery comprise a liquid container?

A. Yes.

Q. Does the battery have a magnesium electropositive electrode?

A. Yes.

Q. Does the magnesium electrode have an exterior terminal?

A. Yes.

[fol. 270] Q. Does the battery have a cuprous chloride electro-negative electrode?

A. Yes.

Q. Does the cuprous chloride electrode have a terminal connected therewith?

A. Yes.

Mr. Reilly: Let the record show that the witness has already covered the specific method of putting the cuprous chloride on the grid.

By Mr. Reilly:

Q. Doctor, does the Chubb patent teach that carbon may be included in the cuprous chloride electrode?

A. Yes.

Q. Doctor, I think I neglected to ask you if the magnesium electrode was inside the liquid container?

A. It is. The liquid container is the spacer.

Q. Doctor, does Chubb have anything to say concerning the use of chlorides in activating the cell?

A. Yes, he states:

> "The addition of sodium chloride or other suitable chlorides to the electrolyte results in a somewhat greater cell voltage and also brings the voltage up more rapidly, than water alone."

Q. Where is that?

[fol. 271] A. At the bottom of column 3, lines 75 and 76, and at the top of column 4, lines 1 and 2.

Q. Thank you, Doctor.

Doctor, going back to the Eagle-Picher letter, the first few pages of Trial Exhibit No. 1, will you read the second sentence of that paragraph on page 1?

A. (Reading) "These essentially contain cuprous chloride plates, the active material of which is bound in place with polystyrene or some other similar resin."

Q. Doctor, does that remark refer to the preceding mentioned Fischbach patent or the preceding mentioned Chubb patent?

A. It refers to the Chubb patent, I think.

Q. Do you agree that the active material is bound in place with polystyrene in the Chubb patent?

A. Yes, sir.

Q. Doctor, referring to that part of Trial Exhibit No. 1 which is the letter from the Ray-O-Vac Company—first let me state on the record I believe that this is a five-page letter. Pages 4 and 5, which are so numbered, are dated December 15, 1960. I do not know the correct number of the other pages but that obviously is the first page (indicating), and the pages which are the last two are numbered 4 and 5. The second page of this letter is either [fol. 272] page 2 or page 3.

In my references to this letter I have called it the Ray-O-Vac letter, and I will refer to it by page numbers 1, 2, 4 and 5.

Doctor, refer to that letter—and I turn to what I have called the bottom of page 2, and there is a statement there which I would like to read:

> "With respect to the processes used by Ray-O-Vac Company in producing magnesium-cuprous chloride batteries furnished to the Government, we have used three different techniques during the period involved."

The paragraph then goes on apparently to the next page, and it describes what I take is the first technique.

Doctor, I would like to have you look at that and give me your comments as to this matter.

A. This could be designated as the "Chubb technique."

Q. Thank you, Doctor.

Does what you say concerning the Chubb patent and its use by Eagle-Picher apply here with equal accuracy?

A. Yes, sir.

Q. Doctor, I would like to have you look further down the page and find where the second process or technique is

described, and when you have found that, will you give me your comments concerning it?

[fol. 273] A. This is essentially the Fischbach technique.

Q. Thank you, Doctor.

Will you turn to the last page of the letter, designated page 5, and look at the third technique, and when you have done so, will you give me your comments on that technique?

A. This is a technique involving blending and unifying by pressure. I do not know what the technique is, but the technique appears to fall in neither the Chubb nor the Fischbach technique classification.

Q. Doctor, for purposes of having it in the record, for whatever it may be worth, in a Stokes tablet machine how much pressure is developed, or can be developed?

A. Depending on the setting, and the size of it, it may be a couple of hundred to several thousand pounds per square inch.

Q. How long have electrodes been made in the art by unifying them simply by pressure?

A. I would say at least fifty years, and probably before that.

Q. Was it one of the techniques used in primary batteries?

A. Yes, it was used in primary batteries, and it probably had a spring upon it, and it was simply put in the screw [fol. 274] press to apply pressure, and it would unify it.

Q. Doctor, referring to the Electric Storage battery in Trial Exhibit No. 1, what does that letter state concerning the manufacture of cuprous chloride cells by Electric Storage Battery Company?

A. It says that they were processed relative to the disclosures in three patents, Nos. 2,640,090, 2,640,091 and 2,667,527. These are the Pucher patents.

Mr. Reilly: For the record the Pucher 090 patent is Trial Exhibit No. 3. The Pucher 091 patent is Trial Exhibit No. 4, and the Pucher 527 patent is Trial Exhibit No. 5.

By Mr. Reilly:

Q. Doctor, in any place in these three patents, what do they say concerning a cuprous chloride cathode made from cuprous chloride, liquefied by water? I don't care whether you find the specific reference or not.

A. They are critical of both of the techniques in these patents.

Q. Doctor, I have just found my note. It is column 2, lines 22 to 33, Trial Exhibit No. 3.

A. There he specifically refers to it in this manner:

> "The preparation of the positive plates presents a major problem as a cuprous chloride and water mixture or paste when dried has very little mechanical [fol. 275] strength and plates made therefrom are easily disintegrated."

Q. Does he say anything about an inert binder with respect to the unified cuprous chloride?

A. He states that when an inert binder is added to it, the result is to reduce both the voltage and the capacity of the cells.

Q. Doctor Mantell, what processes are being criticized in those statements?

A. The Fischbach and Chubb processes.

Q. Doctor, referring to the Pucher patents, broadly what is his proposal for making a cuprous chloride electrode?

A. Broadly, his proposal is to add silver chloride in amounts of four per cent, either to cuprous chloride or to a hydrated cuprous chloride, and then he maintains that this gives him a paste which is easier to handle, and there is a shorter setting time, and it gives good mechanical strength, and it increases the voltage and the capacity of the cell.

Q. In order to save a little time, may I put on the record that the 090 patent concerns the ordinary cuprous chloride, and the 091 patent concerns what is called hydrated cuprous chloride.

A. The "hydrated cuprous chloride" is Pucher's term.

Q. That is Pucher's term?

A. Yes, sir.

[fol. 276] Q. In both cases did you say he added four per cent of silver chloride and water to get a liquefied mix?

A. Yes, sir.

Q. Doctor, what is the significance to you that cuprous chloride and silver chloride are mixed together to form an electrode system?

A. Cuprous chloride and silver chloride are equivalents, and each one functions the same as the other, and each one is able to take the place of the other.

Q. Now, Doctor, refer, if you will, to Trial Exhibit No. 5, which is the Pucher 527 patent, and particularly to the drawings, and I will ask you the same line of questions.

Commissioner Lane: Mr. Reilly, it is about time to give your witness a rest.

Mr. Reilly: That will be fine. Thank you, Your Honor, so much.

(Short recess.)

Commissioner Lane: You may continue.

Mr. Reilly: I would like the record to show that during the recess Doctor Mantell and I were in here and we put some litmus paper in the batteries to obtain a pH reading, but otherwise we did not disturb them, and when we came back, as you will notice, one of the batteries was out. It is probably a bad contact.

[fol. 277] Commissioner Lane: I noticed that one of them was getting a little dimmer.

By Mr. Reilly:

Q. Doctor, when you get a poor contact or a bad contact with a battery, does the battery keep on working?

A. Yes, sir.

Q. But you do not get any reading out of it, is that correct?

A. That is correct.

Q. Doctor, will you take the two cells out of the water and put them in dry beakers, and we would like to have the Court observe that these batteries continued to operate after they are undone.

A. (Witness complies)

Mr. Arseneau: Do you mind if I ask which battery had the bad connection?

Mr. Reilly: I regret to say it was the one that had the pasted plate.

Mr. Arseneau: I understand.

Mr. Reilly: And I feel that it was entirely due to the connection.

Mr. Arseneau: I understand.

Mr. Reilly: The battery works fine.

We are going to keep the liquid next to the battery, and [fol. 278] we will have the reaction proceeding, as I understand it, and you do not have to go through an initial delay period.

(At this point the witness adjusted the batteries)

By Mr. Reilly:

Q. That looks better. Doctor, I am sorry I did not ask you before, but did you notice if the reaction was proceeding in the water?

A. The reaction was proceeding on the batteries in that there were small bubbles of hydrogen in both of them on the surface of the magnesium.

Q. Doctor, referring to Trial Exhibit No. 5, which is the 527 Pucher patent, will you look at that patent and the drawings and specification and tell me if it discloses a battery.

A. It does.

Q. Does the battery comprise a liquid container?

A. It does.

Q. A magnesium electropositive electrode?

A. Yes.

Q. That is column 4.

A. Yes, sir, I have it.

Q. Is the electropositive electrode inside the container?

A. Yes, sir.

[fol. 279] Q. Does it have an exterior terminal?

A. Yes, sir.

Q. Is there a cuprous chloride electronegative electrode?

A. Yes, sir.

Q. And is there a terminal connected with that electronegative electrode?

A. Yes, sir.

Q. Doctor, does this, or any of the other patents, contain any mention of carbon?

A. How is that?

Q. Does this Pucher patent, or any of the other Pucher patents, contain any mention of carbon?

A. (Examining patents)

(Discussion off the record.)

Commissioner Lane: Back on the record.

Mr. Reilly: Mr. Arseneau will stipulate that nowhere in those patents is there a mention of carbon.

By Mr. Reilly:

Q. Now, Doctor, going back again to Trial Exhibit No. 1, would you refer to the Burgess Battery letter, skipping the first page and going on to the second page, where it says:

"III Techniques," and will you comment on the [fol. 280] process disclosed in that paragraph?

A. Under III it is described as consisting of "a paste of cuprous chloride, plastic binder, and graphite"—which is the carbon—and that the paste is spread on an open mesh cotton gauze and then dried and pieces of it comprise the cuprous chloride electrode.

Q. Is this the same as anything you have seen before?

A. This is similar to Chubb.

Commissioner Lane: Doctor Mantell, what is the significance of the difference in color between th solution in these two beakers?

The Witness: It is probably the case that the difference in color is that there is a little greater concentration of what might be a copper compound in the solution with magnesium.

Commissioner Lane: Is there a difference in time which might account for it?

The Witness: The character of the two electrodes might account for it.

By Mr. Reilly:

Q. Doctor. I wish you would take the one which was put in the glass and put it back in the water for a while.

A. Yes, sir. (Witness complies)

Mr. Reilly: Does anybody remember the approximate difference in time?

[fol. 281] Mr. Arseneau: About ten minutes.

Mr. Reilly: Let us put it back for about ten minutes and see what it looks like then. It is now about five to twelve.

Mr. Arseneau: What battery is being immersed in water?

Mr. Reilly: That is the one made according to Doctor Fischbach's patent, Trial Exhibit No. 2.

By Mr. Reilly:

Q. Doctor, one more question on the Burgess battery, and then I want your comment on the second page of the letter. Will you indicate who is the author of this letter, and where he appears to work in the Burgess Company?

A. The letter is signed by J. A. Macdonald of the Sales Department.

Q. Thank you, Doctor.

Tell me, Doctor, do you consider a sales person to be a competent person to go to for such a disclosure?

A. I would not. I would be skeptical of his impartiality.

Q. Would you be skeptical of the technical nature of the information which might be transmitted?

A. Yes, sir.

Q. Thank you, Doctor.

Doctor, I would like to get all this information which [fol. 282] we have been discussing in one place, if I can, and I am going to ask you if we can find some way to do it, to make up some little chart here with the physical steps or phases involved in the various ways of making cathodes in some kind of organized presentation.

What I plan on asking you to do is to start off at one side of a piece of paper and put down the steps or the physical steps or phases that Adams goes through in making his cathode, and then do the same thing with respect to some of the other people.

Doctor, I think we have a marking pencil here which might be useful. (Handing marking pencil to the witness)

Doctor, will you put down "Adams" and then the first step?

A. Yes, sir.

Q. What is the first physical step in Adams?

A. The first physical step in Adams is mixing (marking chart).

Q. What is the second physical step?

A. Blending and liquefaction.

Q. Doctor, just underneath there, in some way in parentheses, will you put down the specific page where it is disclosed, by which Mr. Adams accomplishes the liquefaction, I mean under the step "liquefaction"?

[fol. 283] By heat. (Marking chart)

Q. What is the third step, Doctor?

A. Forming, molding or shaping.

Q. Doctor, what is the fourth step?

A. Solidification.

Q. All right, Doctor, would you put numbers over on the left-hand side, 1, 2, 3, 4, against those? I mean down the left-hand column.

A. Yes, sir. (Witness complies)

Q. Doctor, in Adams, how does he accomplish the solidification?

A. By withdrawal of heat.

Q. In other words, he stops what he was doing?

A. That is right.

Q. Now, Doctor, to the right of the Adams' column will you draw a vertical line and do the same thing for Doctor Fischbach?

Mr. Arseneau: I wonder if I might ask is the Doctor duplicating on the board the paper which he has at the present time?

Mr. Reilly: I do not think he is using it.

The Witness: I have sort of recollection notes.

Mr. Reilly: I don't have them written out, Mr. Arseneau.

Commissioner Lane: Do you care to see the notes?

[fol. 284] Mr. Arseneau: I would like very much to see the notes which are being used in this connection.

Mr. Reilly: Here (handing notes to counsel for the Defendant).

Mr. Arseneau: I may be mistaken, but it looks to me like the word "mixing" might be "liquefaction," talking about the left-hand column, forming, molding or shaping, and then solidification, and that you have duplicated them.

Mr. Reilly: I think I would like to have the Commissioner see what you are looking at.

Mr. Arseneau: My question is whether the witness was duplicating on the board a chart which he was holding in his hand.

Mr. Reilly: Now what he is doing is he is not using a chart but is using it to refresh his recollection.

Doctor, why not put the chart down and let us go to Mr. Fischbach.

Under the ruling with respect to documents which the witness has been using, they are admissible and I will ask that they be marked as the next Plaintiffs' Exhibit No. 35.

Commissioner Lane: The witness' notes may be marked Plaintiffs' Exhibit No. 35 for identification. Do you want him to continue to use them or not to use them?

Mr. Reilly: I want him to continue without them because [fol. 285] I can use them.

(The notes referred to heretofore by the witness which were being used in the preparation of the chart on the blackboard were marked for identification as Plaintiffs' Exhibit No. 35.)

By Mr. Reilly:

Q. Now, Doctor Mantell, would you do the same thing for Mr. Fischbach, please?

A. Fischbach does his blending and liquefaction.

Q. I want you to write down there, if you will, some indication. You said that Fischbach does his blending and liquefaction, and will you kindly write that in so that we will know what you have in mind? I do not mean under Mr. Adams, now, but under Fischbach.

Did you say he also had a blending and liquefaction step?

A. Yes, sir. Fischbach.

Q. Will you write it down there?

A. (Witness complies)

Q. Does he have a forming, blending or shaping step?

A. Yes, sir.

Q. Doctor, to get this down clearly, Mr. Adams is forming, molding or shaping with a mold, is he not?

A. Yes, sir.

[fol. 286] Q. You have written "By water" under No. 2?

A. Yes, sir.

Q. Will you indicate under No. 3 the specific Adams move, and then indicate how you would designate the method of Doctor Fischbach? Are they the same? Do you call it a paste?

A. Yes, sir, a paste.

Q. Put that down then.

A. (Witness complies)

Q. Does he have a solidification step?

A. Yes, sir.

Q. All right, will you note that there?

A. (Witness complies)

Commissioner Lane: If I may interrupt, Mr. Reilly, if they are the same, can it not be so indicated?

Mr. Reilly: Thank you, Your Honor. I will follow that.

By Mr. Reilly:

Q. If they are the same, Doctor, will you put down "same"?

A. Yes, sir.

Q. Let me digress for just a moment. I think there was some interest concerning the matter of these batteries here, and they have both been in there for approximately the same length of time, and I don't know what it signifies, but there is a difference in color.

[fol. 287] Doctor, do you think it might be well to take a reading on this?

A. Yes.

Q. Suppose you take a pH reading. What are you going to do, Doctor?

A. I have here a so-called pH paper, which is a paper which changes its color, and the color will correspond to

one of these colors and the pH will be read according to the color. (Indicating)

The pH, Your Honor, does not go quite to 6 but closer to 7, and it is somewhere in between 6 and 7.

Q. Which one did you measure, Doctor?

A. I measured the one which is labeled "heat."

Q. That is the one with the cathode made by liquefaction with heat?

A. Yes, sir.

Q. Would you measure the other one, Doctor?

A. (Witness complies) Here the color does not correspond to 7 but corresponds more closely to 6.

Q. So roughly they are both between 6 and 7?

A. That is correct. The one labeled "water" is alkali and acid, and the one is labeled "heat."

Q. But they are both on the acid side of the scale?

A. They are on the acid side, yes, sir. It is possible [fol. 288] that the water we had had a pH which was close to 6, and if we can tell about the water, we can check it.

Q. I think it would be interesting to know what the start of it was. Doctor, let us go back to your chart for just a moment. I see by your notes that I have missed something. In that mixing step, does Mr. Adams use carbon as well as cuprous chloride?

A. Yes.

Q. Will you indicate in connection with the mixing step for Adams, whether it is with or without carbon?

A. (Witness marks chart)

Q. Doctor, will you try the pH reading on the water we have here now, and see what it reads?

A. (Witness complies) It is close to 6.

Q. The starting point of this water is close to what it is now? Is that correct?

A. That is correct.

Q. All three samples are between 6 and 7?

A. That is correct.

Q. Now, Doctor——

Mr. Arseneau: I wonder if there would be any objection to noting that the pH was tested on the tap water, which

was not used contemporaneously with the construction of the samples.

Commissioner Lane: The record may show that fact.

[fol. 289] By Mr. Reilly:

Q. Doctor, does Doctor Fischbach also teach with or without carbon?

A. Yes, sir.

Q. Would you note that there and use an abbreviation for it?

A. (Witness complies)

Q. We have got "mold" down for No. 3, and under No. 4 we have got "withdrawal of heat." How did Mr. Fischbach accomplish the same solidification that you have noted there?

A. By the withdrawal of water, by liquefaction.

Q. Put that down, Doctor.

A. Yes, sir. (Witness complies)

Q. What about Chubb? Let us draw a vertical line and put down No. 3 for Mr. Chubb and run it on down for him.

A. Yes, sir. (Witness complies)

Q. Does he have a mixing step?

A. Yes, sir.

Q. Then write it down.

A. Yes, sir. (Witness complies)

Q. Does he also have "with or without carbon"? Does he teach you can put in carbon if you want to?

A. Yes, sir.

Q. All right, put that down.

[fol. 290] A. (Witness complies)

Q. Take up the No. 2 step next, Doctor.

A. He uses resins and solvents.

Q. Will you note that, please?

A. Yes, sir. (Witness complies)

Q. What is Doctor Chubb's next step?

A. His next step is forming, molding or shaping by pasting.

Q. Put that down, please.

A. (Witness complies)

Q. What is his next step?

A. His next step is solidification, withdrawal of the solvent.

Q. Will you note that, please?

A. Yes, sir. (Witness complies)

Q. Let us turn to the Pucher patents. Put a line down and put down No. 4 for Pucher.

A. Yes, sir. (Witness complies)

Q. What is his first step, Doctor?

A. His first step is mixing with silver chloride, although he might also add electrolytes.

Q. Indicate that he uses silver chloride.

A. (Witness complies)

Q. You have indicated that he uses silver chloride [fol. 291] instead of carbon, Doctor?

A. Yes, sir.

Q. What about the second step?

A. The second step is essentially a forming by pasting.

Q. What substantially does he use?

A. He uses the same sort of mix as Fischbach does, essentially, with water.

Q. Doctor, if you want to refresh yourself with any of the patents, tell me about it.

A. Yes, sir.

Q. What is the third step, Doctor?

A. It is essentially pasting.

Q. What about the next step?

A. By withdrawal of the liquefaction agent, in other words the withdrawal of the water.

Q. Will you get some more paper for this purpose, Doctor, so that we can put down Ray-O-Vac?

A. Yes, sir.

(Producing second sheet of paper)

Q. Doctor, I want you to show all of this information for Ray-O-Vac.

Here is Ray-O-Vac, Doctor. Can you remember what you said about Ray-O-Vac's No. 1 step?

A. Yes, that Ray-O-Vac's No. 1 step is essentially [fol. 292] Chubb.

Q. Let us shorten it up and write under Chubb that it is the same as Ray-O-Vac No. 1.

A. (Witness complies)

Q. What about the No. 2 step, Doctor?

A. His No. 2 step is essentially Fischbach.

Q. Put that down in the Fischbach column in the same way.

A. (Witness complies)

Mr. Arseneau: I would like to ask in connection with this chart, is there any objection to showing that there have been three Pucher patents discussed, and that all of them are in as Trial Exhibits?

Mr. Reilly: I thought it was clear enough.

By Mr. Reilly:

Q. Put down the Pucher patents, if you will, please, Doctor.

A. (Witness complies)

Q. How about Ray-O-Vac No. 3, Doctor?

A. Ray-O-Vac No. 3 is the unification process by blending and cohesion.

Q. Doctor, let us start a column for Ray-O-Vac No. 3 and check these steps to see whether they are or are not present.

A. (Witness complies)

[fol. 293] Q. Is there a mixing step in Ray-O-Vac No. 3?

A. Yes, sir.

Q. What is it?

A. It is with carbon.

Q. Please note it.

A. (Witness complies)

Q. Is there a blending or liquefaction step?

A. Unless I know more about what his agent is, I can't cite it.

Q. Will you put down a question mark there?

A. (Witness complies)

Q. Is there forming, molding or shaping?

A. Yes, sir.

Q. Is there a solidification step?

A. Yes, sir.

Q. I think the only one left is Burgess, and I will hand you Trial Exhibit No. 1 and ask you to recall, if you will, what you said concerning the process of Burgess in that exhibit.

A. Burgess is following the technique of Chubb.

Q. Will you indicate that underneath the marking concerning Ray-O-Vac No. 1?

A. (Witness complies)

OFFERS IN EVIDENCE

Mr. Reilly: I offer this chart in evidence, the two pages of the chart as it presently stands, as Plaintiffs' [fol. 294] Exhibits Nos. 36-1 and 36-2.

Commissioner Lane: It will be received in evidence.

(Chart drawn by the witness with three headings, "Adams, Fischbach, Chubb, Pucher patents and Ray-O-Vac" received in evidence as Plaintiffs' Exhibits Nos. 36-1 and 36-2.)

By Mr. Reilly:

Q. Doctor, I hand you page 202C through page 204C of the Journal of the Electrochemical Society, August 1952, and I will ask that that be identified and received in evidence under our stipulation concerning publications as Plaintiffs' Exhibit No. 37.

A. (Witness examines)

Commissioner Lane: Mr. Reilly, for what purpose is this exhibit offered?

Mr. Reilly: These are two articles from the Anniversary Issue of the Journal of the Electrochemical Society, which compares side-by-side characteristics of the silver chloride system and the cuprous chloride-magnesium system, and also shows some of the recognition in the art, and the great area of distinction of these two types of systems from other types of batteries.

Commissioner Lane: I will reserve any ruling on admissibility until the Defendant has had a chance to examine it. [fol. 295] Mr. Reilly: Very well, Your Honor.

By Mr. Reilly:

Q. Doctor, would you look at this and take your time and study these pages, and I want you to compare the article on Silver Chloride-Magnesium Reserve Battery, by Blake, which starts on page 202C, with the Cuprous

Chloride-Magnesium Reserve Battery by Mr. Pucher, which I believe we have seen before, and give me your comments on these two articles, if you will, please?

A. In the Blake article the silver chloride-magnesium activated battery it is said became available on a commercial basis in 1943, and in the Pucher Cuprous Chloride-Magnesium, Water-Activated Reserve-Type Batteries, they are said to have first been made commercially in 1949.

In the Blake article the statement is that the silver chloride type became more numerous as to its application in 1945 to 1952, and they are now produced on a commercial basis for a diversified list of civilian and military uses.

Blake then describes the system of the silver chloride-magnesium cell as an anode of magnesium, a cathode of silver and silver chloride, and an absorbent separator of cellulosic material.

He then gives the reactions.

[fol. 296] Pucher does a similar thing in describing his system, and he gives the cell reaction. Incidentally, in the Pucher article there is a mistake here in the equation, which is given as $Cu_2Cl_2 + Mg + CH_2O$, and it should be, as shown by a later reading of the paragraph "$6H_2O$," and the "C" should be "6" on both sides of the equation.

If you took the Blake equations and put them in one equation, and then substituted monovalent copper for monovalent silver, then the two reactions are the same.

Blake then describes how the reactions proceed, and Pucher describes how the reactions proceed, and in both cases I believe the reactions are the simplest possible and do not represent the actual things which happen in the cells. The reactions are much more complicated.

Blake then compares the cells and in Figure 1 he gives the discharge characteristics of the silver chloride-magnesium cell. I would like to point out the flatness of the curves at the top A, B and C, and those are typical of the linear potential types of curves.

When Pucher makes comparison of performance, he does that in Figure 1, and the one cell unit of Figure 1 of Pucher again shows the flat constant voltage curve.

The statement in Blake as to the uses is:

"These batteries are used in airborne electronic [fol. 297] equipment, signal lights, emergency flares, lights for pilot balloons, marker lights for floating buoys, light units for movie work, d.c. motors, Radiosonde units for weather observation work, emergency radio equipment, air-sea rescue equipment, ignition systems, emergency lights for hospitals, and direction finding equipment."

Pucher does not have as much detail but he says that the cuprous chloride battery was developed for the military.

Pucher finishes by saying:

"Cuprous chloride-magnesium batteries are characterized by good current and power-output, almost constant potential, long shelf life, and are capable of being discharged in temperatures as low as —50° C. after being activated at room temperature. They have a considerable cost advantage over the silver chloride-magnesium cells which have similar characteristics."

Q. Doctor, I have just one question which I would like to put to you concerning the statements with respect to the two articles. I will read you from the Blake article this statement, from the first column, the fifth paragraph:

"Silver chloride-magnesium batteries, after activation [fol. 298] in water to a temperature above 0° C, can be discharged at ambient temperatures ranging from +94° C to —54° C, with outputs at either extreme of the temperature range being substantially the same as the output at +21° C."

In the Pucher article I will read you this:

"The discharge reaction is sufficiently exothermic to cause overheating on high current drains. This characteristic can be utilized to advantage in cells which must be operated in extremely low temperatures, for example, at —50° C (—58° F) with activating at room temperature."

Doctor, do you agree with the statements by both Mr. Blake and Mr. Pucher concerning the respective battery systems which they were discussing?

A. I do.

Q. Doctor, in the battery art, is that characteristic one of unusuality?

A. It is one of unusuality, and in all its aspects it is the property of these two systems.

Q. Is it the exclusive property of these two systems?

A. If you take all of the characteristics together, yes, and if you take them individually, no.

Commissioner Lane: We might recess for lunch, if this [fol. 299] is a good stopping point.

Mr. Reilly: Thank you, Your Honor.

Commissioner Lane: We will recess now until 2:00 o'clock.

(Whereupon, at 12:30 o'clock p.m., a recess was taken until 2:00 o'clock p.m.)

AFTERNOON SESSION (2:00 o'clock p.m.)

Commissioner Lane: All right, gentlemen.

WHEREUPON CHARLES L. MANTELL, the witness on the stand at the taking of the recess, resumed the stand and testified further on behalf of the Plaintiffs as follows:

Direct examination (Resumed)

Mr. Arseneau: There was something left hanging before the luncheon recess, which I would like to take up.

Commissioner Lane: Very well.

Mr. Arseneau: There was an exhibit referred to with respect to the Electrochemical Society by Mr. Blake and one by Mr. Pucher, and I think some reference was made to a stipulation to be entered into.

If I am not mistaken, I think that stipulation is the stipulation, a ribbon copy of which was handed up to the [fol. 300] Commissioner at the pretrial conference.

That numbered stipulation mentions the agreement of

both parties with reference to using uncertified copies which can be considered as having been filed, granted or published on the dates and places appearing on them, and also with respect to the names of the authors appearing thereon, it was stipulated that the names as they appear are correct subject to correction.

We are content to go along with as much of the stipulation as I have read, but, however, the stipulation is not to be considered as a blank admission by us as to the facts stated in the articles referred to.

I will say that we have never stipulated that the running text of such material is evidentiary with respect to the facts stated therein, and for that reason I would object strenuously to their being received in evidence as such.

Moreover, since the running text is hearsay and has not been proved by the witness, we take the position that any opinion testimony based upon these articles should be stricken. The opinions used by the witness are based on facts he has assumed, and have never been proved prior to his giving his opinion.

Mr. Reilly: Your Honor, the stipulation covered what Mr. Arseneau said, and these documents are like any other publications.

[fol. 301] They are not to be taken as proof of the facts stated therein, and I agree with Mr. Arseneau, when he says that because a publication states that these are the reactions of the magnesium-silver chloride cell, it does not mean any more than if Mr. Arseneau puts in a patent and says that it shows such and such a thing, it does not mean that that is proof that that is what happened.

The whole purpose of the publication was to prove that these are the published statements of these people, and that was the only purpose of it.

This publication will be added to other statements, including the publications in Commissioner's Exhibit No. 2, which are the publications of the Army Battery Conference, and certain other publications and the entire document was offered to show all the articles in the art that these people have seen, and which Defendant produced, and in which certain statements are made concerning the batteries.

We do not expect anybody to admit that these articles

are proof of what is stated in them. Therefore, Your Honor, I feel that this exhibit should be received as a publication.

Commissioner Lane: It was marked Plaintiffs' Exhibit No. 37 for identification. Do you have any further comments with regard to the offer of it, Mr. Arseneau?

Mr. Arseneau: I seemed to have lost track of the copy.

[fol. 302] OFFER IN EVIDENCE

Mr. Reilly: Here (handing document to counsel).

Mr. Arseneau: Thank you very much. The only comments I care to make are such that it would be repetitious. Since any statements stated therein with respect to the contractors and the like are hearsay, I repeat the objection that any opinion given by an expert, based on these matters, is inadmissible.

Commissioner Lane: As I understand the offer, this is not offered as evidence of the truth stated therein, but it is merely evidence of what information was published by certain people. Whether it is true or not, we have no problem here with respect to the truth of what was published by these people.

Mr. Reilly: That is correct, Your Honor.

Commissioner Lane: On that basis I will receive Plaintiffs' Exhibit No. 37 in evidence.

(Pages 202C, 203C and 204C from the Journal of the Electrochemical Society, August 1952, were received in evidence as Plaintiffs' Exhibit No. 37.)

Mr. Reilly: Thank you, Your Honor. In the afternoon I neglected to make any mention of the battery.

By Mr. Reilly:

Q. Doctor, I notice that one battery has gone out, and the other looks like it is about to go. What happened [fol. 303] to them, has it dried up, maybe?

A. It may be beginning to dry up.

Q. Stick it back in the water.

Mr. Arseneau: Is it fused?

Mr. Reilly: They are both fused, Mr. Arseneau. One is melted by heat and the other is melted by water.

Mr. Arseneau: Let me resort to the terminology in the future. It is simple to refer to it as being melted and subsequently cooled.

Mr. Reilly: It was simply produced by liquefaction and subsequently solidified, left alone, and the one which is dimmer is the one produced by water and solidified by being left alone by itself.

Mr. Arseneau: Thank you very much.

Mr. Reilly: I am referring to Trial Exhibit No. 18, which, if I am not mistaken, is the one which is the sample of the silver chloride battery.

Mr. Arseneau: Designate the one that is the silver chloride battery.

Mr. Reilly: Mr. Arseneau, do you have any objection to our taking this part to examine it?

Mr. Arseneau: This is a sample battery, but I have no objection.

Mr. Reilly: I will note for the record that there is a [fol. 304] very simple label on it entitled "Burgess," and underneath it is the designation "X10183," and then written in fountain pen are the letters "6A."

Mr. Arseneau, can you advise me as to whose writing "6A" is?

Mr. Arseneau: No, I can only say that the "6A" was on it when I received it from the Navy.

Mr. Reilly: Thank you, Mr. Arseneau.

By Mr. Reilly:

Q. Doctor, will you take this apart, and possibly His Honor would like to see it before it is touched.

Commissioner Lane: I have examined it previously.

By Mr. Reilly:

Q. Will you see if you can do anything about disassembling it, Doctor?

A. Yes, sir. (Witness complies)

Q. Doctor, while you are disassembling that, I wish you would keep an eye on the parts because I am going to take you through the line of questions which we have been through previously with reference to the component parts of the battery. As you take it apart, note what you are

disassembling, and from what it comes, and the location of the parts, please.

A. Yes, sir.

[fol. 305] Doctor, both of the batteries seem to be pretty much on their way out.

A. Yes, sir.

Mr. Arseneau: Are you still trying to recuperate these batteries?

Mr. Reilly: The current is still on.

Commissioner Lane: Will they revive any faster if put in fresh water as opposed to the previous activation?

The Witness: No, sir.

Mr. Reilly: It went on and then went off.

Let the record show that the battery which was made with cuprous chloride liquefied by heat went off during the luncheon recess, and that the battery which was made with water is just about on its last legs now, at 2:15.

Commissioner Lane: Very well.

(Witness continues to disassemble battery as requested)

Mr. Reilly: I wonder if I might save some time if we had Mr. Huettner do this while the Doctor goes on with his testimony. Would it make any difference?

Commissioner Lane: No, we have time.

Off the record, Mr. Reporter.

(Discussion off the record.)

Commissioner Lane: Back on the record.

The Witness: The construction appears to be a magnesium [fol. 306] anode with a plate on which the deposit is silver chloride and the plates are spaced by spacer knobs, which appear to be a form of plastic.

Mr. Arseneau: Do you mind if I look at that?

The Witness: Not at all (handing to counsel for Defendant).

(Discussion off the record.)

Commissioner Lane: Back on the record.

Mr. Reilly:

Referring to Trial Exhibit No. 18, counsel for both parties have had a discussion, and as a result thereof Mr. Arseneau will look into the matter of how his correspond-

ence designates the components of this battery, and also as to whether or not, if one electrode is silver chloride, whether it is "fused," as he uses the term, and he will advise us in the morning, and I thank you very much for your statement.

Commissioner Lane: You can proceed.

By Mr. Reilly:

Q. Doctor, I hand you a copy of Plaintiffs' Exhibit No. 2. Can you remember anything concerning the characteristics of the curves shown on page 1 of Plaintiffs' Exhibit No. 2?

A. The potential curve rises in the course of lengthening here, and after that it remains level and constant for an appreciable time period, and is thus linear in the words [fol. 307] of Adams, and is parallel approximately to the base ordinate.

The load curve is plotted, but without any statement of the load except by indirection, and that curve is flat, linear and parallel to the base ordinate over an appreciable period of time, in the same order as the potential curve, which is from 9:10 to 6:45, the next day appeared a couple hours, less than 24 hours.

Q. Doctor, will you check the date there? It seems to be a little confused. Will you check the time?

A. Wait a minute, the times are here.

Q. Check the dates, please.

A. 9:10 p.m., starting on August 26th, and running through until 6:00 a.m. on August 27th, apparently through that day to 10:45, and that would be 9:10 p.m. to 10.45 p.m. of the next day, more than 24 hours.

Then the next reading is taken at 6:45 a.m., which would be the next day, the 28th of August, so that that is of the order of 24 plus approximately 9 hours.

Q. That is close enough, Doctor.

A. August 28th is down below, opposite the 6:45.

Q. Doctor, looking at the base of the curve marked showing the recorded voltage, can you tell me what kind of a battery system or battery systems can produce this type of a curve with that voltage?

[fol. 308] A. The type of system that would produce this

type of curve, with the voltage, would be the magnesium-cuprous chloride system.

Q. Doctor, what would you say concerning the operation of a battery that produced this curve?

A. It is distinctive and it is the type of operation which is usually associated with the magnesium-cuprous chloride type of system.

Q. Would you characterize it as a successful battery or an unsuccessful battery, or how would you characterize the performance indicated by the curve?

A. I would say that it was a successful battery, inasmuch as it would be able to find specific application for which it would completely satisfy all needs.

Q. Doctor, can you tell me from two volts what the approximate load would be?

A. Unless I assumed the complete brightness of it, I could not tell, and I have to make assumptions of the brightness.

Q. All right, Doctor. I am going to refer you to——

Mr. Arseneau: Read the last question and answer, please, Mr. Reporter.

(Question and answer read.)

Mr. Arseneau: Thank you.

[fol. 309] By Mr. Reilly:

Q. Doctor, I will hand you a copy of Trial Exhibit No. 15, pages 1 to 5. Do you have a copy of that, Doctor?

A. Yes, sir.

Q. Doctor, will you turn to page 2?

A. Yes, sir.

Q. Entitled "Characteristics of Neutro Cell."

A. Yes, sir.

Q. I am going to ask you to assume, Doctor, that the neutro cell is magnesium-cuprous chloride, and the first statement is:

> "This cell is based on a new type of electro-chemical action."

Doctor, do you consider that statement to be true or false?

A. I consider it to be true, inasmuch as this combination of magnesium and cuprous chloride-water-activated is a new system in the broad sense.

Q. Doctor, if someone had told you in 1940 or 1942 of such a new system, would you have been inclined to believe it, or would you have felt that it was an old type of electro-chemical action?

A. I would have been inclined to have been skeptical.

Q. I will read you the next sentence:

[fol. 310] "It can be stored indefinitely without alteration or loss of power until the moment it is used."

Is that true or false?

A. That is true, if stored dry and not exposed to moist air.

Q. Doctor, it says:

"What potential drop has cell under load?"

And then it says:

"10% under full load and then linear until spent."

Is that true?

A. Approximately true, yes, sir.

Q. If someone had told you they would offer a battery in 1940 with thath characteristic, would you have been skeptical?

A. I would have been skeptical, and I certainly would have desired to be shown.

Q. Under the paragraph two or three sentences down it states:

"Is electrolyte used?"

And it states:

"No—No acids, alkalines or any other liquid other than plain water is used in this cell. Water does not have to be distilled."

Is that true or false for the magnesium-cuprous chloride
[fol. 311] system?

A. It is true.

Q. Doctor if someone had told you in 1940 that they had a battery with this charactistic, what would your reaction have been?

A. Again I would have been skeptical and would have desired to be shown.

Q. Skipping down a paragraph the question is:

> "Does polarization take place under rapid discharge?"

And then it states:

> "No. Owing to this fact the potential remains linear until spent."

Is that true or false?

A. In terms of the statements which are made, there is an error or inaccuracy because polarization does take place. You have a material which functions as a depolarizer in the cell. The statement, ". . . the potential remains linear until spent" is true. It is just a question as to what is the reason for it.

Q. Doctor, do you know any reason why the potential remains the same on this?

A. No, I don't in terms of theory.

Q. The next paragraph reads:

[fol. 312] "Can this cell be short circuit?"

And then it says:

> "Yes, without any harm other than the normal consummation of current for the duration of short, . . ."
> —and I believe that is intended to be "consumption"——

Doctor, considering as much as I have read, is that true of this system?

A. Yes, that there would be a waste of current during the period of the short.

Q. Do other batteries function that way?

A. I would say battery systems broadly will function that way but they will use current during the period of the short.

Q. If you shortcircuit an ordinary battery, for, say, an hour, that does not bother it?

A. It bothers it to the extent that that portion of the life is gone.

Q. But if the battery, for example, had thirty hours of life, it would have one-eighth of thirty less?

A. If that be the rate.

Q. I mean in the electric storage battery, for example.

A. The electric storage battery, if you short the battery, you may develop enough heat in the shortage to burn your [fol. 313] contact.

Q. The next paragraph reads:

> "Will cell work at both extremes of temperature? It has been tested at 40 F. below and at 200 F. above 0."

Doctor, I will ask you, does this cell work at 40 degrees Fahrenheit below?

A. It does work at 40 degrees Fahrenheit below.

Q. Does it work below that temperature?

A. Yes, it can be designed to work below that temperature.

Q. Doctor, if somebody had come to you in 1940 with page 2, the whole page, would you have believed what was on there?

A. I would have had considerable difficulty in making myself believe it, and I would not in general have believed it.

Q. Doctor, do you know of any other battery system today, other than magnesium-cuprous chloride-water and magnesium-silver chloride-water, which will have all these charactistics?

A. No, I do not know of any battery system which will have all those characteristics.

Q. Doctor, I am going to show you Plaintiffs' Exhibit [fol. 314] No. 4 and ask you if you have seen that before? (Exhibiting Plaintiffs' Exhibit No. 4 to witness)

A. Yes, I have.

Q. When did you see it before, Doctor?

A. Approximately a week or ten days ago, at which time

you asked me whether I would take a sample of the contents.

Q. Did you do so?

A. I did so by pushing glass tubes down through the opening in the battery, and gathering some of the contents in the whole glass tube, and then withdrawing it.

Q. What did you find, Doctor?

A. I have had an analysis made by a commercial laboratory, and that analysis indicated 10.04 copper on a dry basis, or actually ten per cent of magnesium, a small amount of chlorides, 2.39 sulphate and 25.94 water, which was determined as the volatile loss of weight at 110 degrees.

Q. Doctor, what does that information signify to you?

A. What?

Q. What does that information signify to you?

A. It would signify to me that the battery had been made with magnesium-cuprous chloride and water, and probably a sulphate salt.

Q. Thank you, Doctor.

Doctor, referring back briefly for a moment to Trial [fol. 315] Exhibit No. 15, the one which you have before you, would you turn to the page behind the one we have previously been discussing, which reads:

"Some possible uses of the Neutro Cell."?

A. Yes, sir.

Q. I will read the first line, which says:

"Emergency source of light and power of Submarines, Warships, etc."

Is that use made of these battery systems today?

A. Yes, sir.

Q. Paragraph 4 says:

"Filament current for Army portable radio transmitters. This use is very important when we consider that the common dry cell must be kept away from dampness and cannot be stored indefinitely. This cell owing to its linear output would eliminate much of the fading due to low filament current. The transmitting tubes need not be of high potential filament but can be

made with a heavy filament of low potential and higher drain in amperes. The above applies also to receivers."

Doctor, is it true that this battery has such a use?

A. Yes, it has achieved such a use.

[fol. 316] Q. And is this analysis of the problems involved with transmitting tubes correct?

A. I would say it is in general correct.

Q. And does this battery system power such filament tubes or transmitting tubes effectively?

A. To my knowledge, yes, and effectively.

Q. Thank you, Doctor.

Doctor, do you have a copy before you of Plaintiffs' Exhibit No. 14?

A. Yes, sir.

Q. Doctor. will you look at that Plaintiffs' Exhibit No. 14 and note the drawing, and tell me what significance you find from the information on this exhibit?

A. This drawing would indicate that what Adams was trying to convey was a series of parallel plates stacked together, to put them in series and obtain a higher voltage battery, and also the idea that you could dunk the whole battery.

Q. At one time?

A. At one time.

Q. Thank you, Doctor.

Do you have a copy of Plaintiffs' Exhibit No. 17 before you, Doctor?

A. Yes, sir.

[fol. 317] Q. Doctor, I would like to have you examine this document with particular reference to Paragraphs 6, 7 and 11. Would you indicate to me, Doctor, what significance you find this document conveys?

A. This document would convey to me that the writer of it appreciated the manufacturing limitations and the importance of the internal resistance of the cell, particularly the space between the electrodes. It says in one case that they are three times too large, and he wants to get them closer together, but that his laboratory test units do not achieve it because of the tools he has available.

Q. Does he also say anything concerning square jars or tin cans in paragraph 7, Doctor?

A. Yes, he says that all containers are too large for the cell size, and that is the result of the difficulty of obtaining square jars or tin cans as containers. This was in the period 1943, when we had material allocations.

Q. Doctor, you have testified in relation to Plaintiffs' Exhibit No. 14, that the writer of this document appreciated or wished to manufacture a pile type cell, and you have referred to his reference to the square jar or tin can. Have we seen batteries during the course of these proceedings which followed the directions or improvements contained in these two documents?

[fol. 318] A. Yes, sir.

Q. Would you kindly indicate which of the batteries before you seems to take advantage of the principles involved?

A. Plaintiffs' Exhibit No. 8, Trial Exhibit No. 18, and Trial Exhibit No. 7 are of the pile type of construction and involve boxes, but they are not metal boxes. They are square boxes.

Q. Doctor, in those batteries that you have referred to, for example Trial Exhibit No. 7, do you believe it would make any substantial difference in the over-all operation characteristics in output of that battery, whether it had cuprous chloride electrodes that were made by a process involving water or solvents and binders, or by a process involving melting the cuprous chloride by heat and solidifying it on some sort of a grid?

A. I believe there would be differences in the voltage and capacity, but they would be small and not substantial.

Q. Thank you, Doctor.

Doctor, I hand you a copy of Plaintiffs' Exhibit No. 16, which has been identified as an article or publication, and I ask you if you have had an opportunity to look at this article?

A. Yes.

Q. Doctor, will you comment on this, after you have had

[fol. 319] an opportunity to refresh your recollection?

A. (Examining document) This is an article entitled

"Special Purpose Batteries" by Adolph Fischbach of the Signal Corps Engineering Laboratory at Fort Monmouth, New Jersey. He states in the article:

> "The systems which will be discussed are: the magnesium, water, cuprous-chloride system; the zinc, potassium-hydroxide, silver-peroxide system; and the cadmium, acid, lead-peroxide system."

He also states as follows:

> "Of the three afore-mentioned systems, the magnesium, water, cuprous-chloride system seems to offer the best solution for some of the specialized applications, particularly those where the battery has to be stored for long periods of time; where the battery has to be easily activated at the time it is required for operation; where the power can, or will, be used within a comparatively short time after activation; and where the capacity required per unit of weight and volume is exceptionally high."

He further states:

> "The battery must, of necessity, be activated at more or less normal temperature (above the freez-
> [fol. 320] ing point of water). Since heat is generated during the course of the discharge, this system can be utilized in powering equipments going into cold temperatures, if the proper heat balances are maintained."

That means the design of the battery.

He then discusses the characteristics, and in referring to the development he says that it was first started in early 1946, and——

Q. Can I stop you there?

A. Yes, sir.

Q. In the paragraph which you just passed over, does he state that the examination of the characteristics of the magnesium-cuprous chloride system indicates that it would be capable of relatively cold temperature conditions?

A. He does, and he indicates that in Figure 1, and in reference to Figure 1 he says:

> "The battery was activated by dunking in an electrolyte of water containing 1-per cent cadmium chloride and ¼-per cent ammonium chloride, then shaken to remove excess electrolyte."

He goes on to state:

> "It was discharged for five minutes at 80 degrees Fahrenheit and then placed in the -58-degree-Fahren- [fol. 321] heit cabinet for the remainder of the run."

Now he refers to Figure 1 and he says that curves A and B show that A unit was discharged through 28.4 ohms, and B through 3,833 ohms and are exceptionally flat and uniform, and the discharge curves he is referring to are those in Figure 1, and where the curve is a voltage curve, and A and B are discharged under different loads.

Q. Is this unusual characteristic in the battery which we have been discussing?

A. This unusual characteristic is in the battery which we have been discussing.

Q. Excuse me for interrupting you. Please proceed.

A. He further states that "although the system was first thought to be impractical for battery applications due to its initial self discharge and evolution of heat, the Signal Corps, by continued effort in its Engineering Laboratories, developed a practical operating cell."

And he says further:

> "Then through co-ordinated effort with the battery industry, this cell was developed into a practical battery, utilizing the so-called 'dunk' construction, a design where the cells are individually wrapped and joined externally by a series of welds. The tops and [fol. 322] bottoms of the cells are left open."

That is so that they can be dunked.

The rest of this article compares the other systems and discusses them.

Q. Thank you, Doctor. Let me check something myself for a moment, please.

(Short pause)

Doctor, let me read you a portion that I am particularly interested in in the first paragraph, toward the end:

> "Because of the demand for high discharge rates, high capacity per unit of volume and weight, and other stringent requirements, it was soon recognized that the standard-type primary and secondary types of batteries would be unsatisfactory for these special applications."

Will you comment on that, Doctor?

A. There he was referring to other systems, for example, the sulphuric acid base systems, with lead-cadmium type battery, the dry-cell battery of the zinc-magnesium-dioxide-carbon type, the batteries which had been manufactured in large commercial volume, as well as the alkaline type batteries.

Q. Doctor, were there any standard type batteries as [fol. 323] of the time to which this gentleman was referring, which would have been satisfactory for these special applications?

A. They would have been satisfactory to only a partial degree, and if there was nothing else that could have been used.

Q. Doctor, do you have a copy of Trial Exhibit No. 12, page 2?

A. Yes, sir.

Q. Doctor, I will read you a part of this as follows:

> "Their recollection is that the battery had an extremely high internal resistance and that the current density was very low because Adams' cuprous chloride electrode was very unreactive."

Doctor, what would one do concerning a set of conditions like that with regard to a battery?

A. The solution to a problem like that had long been known in reference to a reduction of high internal resistance. The dry battery industry had long been using elec-

tronic conductors, such as various forms of carbon, to reduce the internal resistance of the battery, and had other systems.

In addition, it was also recognized that the electrode spacers very much affected the resistance of the battery, and in order to reduce it you put them together as close as you could and had electrolyte in between.

[fol. 324] Q. Thank you, Doctor.

Do you have a copy of Trial Exhibit No. 12, pages 11 and 12, before you, Doctor?

A. Yes, sir.

Q. Doctor, have you had an opportunity to examine this exhibit?

A. Yes, sir.

Q. Would you comment on it, please?

A. The thing I would like to comment on is the statement:

> "Inventor's claims of operation at —40° when activated with water alone is untenable unless cell is filled at temperatures above freezing."

Adams certainly did not tell his potential customers to put ice cubes in his cell but, as a matter of fact, he told them to put in water above freezing, and if the cell were properly designed in reference to load, it would heat up, and the heating of the cell would allow operation at low temperatures.

This has certainly been confirmed by many statements of other battery experts who have worked on this particular system.

The statement that the drop in internal resistance is relatively high indicates that there had not yet been applied the techniques which were well known and avail-

[fol. 325] able to the battery industry, and certainly the battery expert would know how to solve that problem to a measurable or large degree.

> "Reasons for specifying the maximum safe load as 300 milliamperes are not clearly understood, but indicate that this cell may be of a type which 'runs away' as a result of local action when overtaxed."

It is interesting to note that all of our battery philosophy up to this time indicated that the battery should be designed not to rise in temperature, but be designed primarily for intermittent service. That is what a battery was good for, and that when you used it in continuous service, the battery would polarize and lose voltage, and it was considered that a battery system consisted of electrodes, with electrolyte, and the electrolyte should be a conductor.

He comes along and says: "I don't do that," and naturally he is received with skepticism, particularly by a man who was one of the outstanding battery experts in the world, and who has probably tested and examined more battery systems than anybody else.

The next has reference to the high watt hour output per unit of weight, and it states:

> "But it is felt that some more definite test data [fol. 326] should be given to support what appear to be unusually large claims"—meaning that the writer of the letter was skeptical.

There is also a statement that it is "based on a new kind of electrochemical action."

Instead of criticizing it on that basis, it is said that "reserve type cells of one kind or another have been known for years."

That means those which are dry and into which you put an electrolyte.

As to whether it is a new kind of electrochemical system or action is not in the criticism. It states:

> "The claim is made that the cell has indefinite shelf life, presumably because it is dry, but the author acknowledges that damp air, if accessible, would speedily render it useless."

We saw some of the commercial batteries which we opened, which had been apparently exposed to moist air and which showed internal corrosion at the beginning of action.

It also states:

> "The statement that this is the only primary cell which does not contain any acids, alkaline or other caustics as electrolyte is nonsense. The ordinary dry cell is a primary cell which does not contain acids, [fol. 327] alkaline or other caustics as electrolyte."

It may be stretching the case because with the same electrolyte you would not want to treat it like distilled water and you would not want to drink it, and it shows an acid reaction. It was that sort of things that Adams was comparing.

They also stated:

> "Magnesium is an important material now and probably not available."

That seems to bear no relation to the problem. If the problem were solved, and if there was necessary need the allocation of metal could be made, and indeed some such allocation was made.

It states:

> "The graphs submitted by the inventor are far from convincing to me. They are drawn with a ruler. There is no indication of the various observations which were presumably taken. The time scale jumps from seconds to minutes to hours."

I can say simply that I have sympathy with Doctor Vinal, when he treats with all the niceties of the process, and when this is compounded by having a graph which looks like it was drawn by a plumber. I think you have to have a sympathetic approach to appreciate whether [fol. 328] the plumber had something in that regard.

Q. Thank you, Doctor.

Doctor, I will hand you pages 17 to 73 of Trial Exhibit No. 12. These are stipulated to be the pages of the gentlemen named William Shorr, who was an employee of the Fort Monmouth Signal Corps Laboratories during the period of time shown in these notes.

Doctor, have you had an opportunity to examine these pages?

A. I have.

Q. Doctor, would you take your time and briefly give us your comments on this group of material?

A. The first page, dated November 26, 1943 and signed by William Shorr, discusses a magnesium-chloride battery patent by B. N. Adams, giving the patent number, June 22, 1943, and then the statement says:

> "Linear potential and capacity.
>
> "Eliminates acid as the electrolyte and hence the evolution of dangerous fumes is avoided.
>
> "The battery is manufactured and distributed in a dry state"—and so forth, as stated.

The statement is made that the cell was made on the general principles as laid down by the inventor, and he took a 250 milliliter beaker and he melted the cuprous chloride by heating into a liquid, and he poured it into a [fol. 329] mold, and gives the dimensions of his mold, and then how he arrived at it. Apparently he was trying to follow the example in the Adams' specific example.

He allowed it to activate for a few minutes, and he had .90 volts, and then it rose to 1.20 volts, and he added some magnesium sulphate, and he reached 1.46 volts, and after 20 hours the voltage was 1.4 volts, and he said that the amperage slowly built up to 500 milliamperes.

Then he repeated this several times, apparently by disconnecting the cell and connecting it again.

He concludes on 11/26/43 with the following words or passage:

> "The battery is feasible. It can be easily constructed and maintained provided the internal resistance of the water electrolyte is partly overcome.
>
> "The battery is not immediately activated on the addition of water, requiring about 15 minutes or more. Can activation be induced immediately?
>
> "Once activated, the battery continues active until exhausted."

Then he raises another question:

> "Can the reaction be inhibited or stopped when the cell is not in use?"

[fol. 330] He raises that question and then he proceeds to make further batteries.

Q. Doctor, may I interrupt you to clear up something?

A. Yes, sir.

Q. Did you find that he followed the specific embodiment of Adams with reasonable care?

A. Yes, he tried to follow it with reasonable care.

Q. Did you note in there any mention of the addition of carbon?

A. He did not add carbon when he heated his cuprous chloride.

Q. Doctor, when he said that the battery is feasible and easily constructed and maintained, do you conclude from that that this first battery was an operating battery?

A. It was at least a battery which satisfied Shorr that it operated to the extent that he thought it was a good battery, and with application of further technique could be further improved.

Q. You noted his voltage and amperage. Does this look like an operating cell, in your opinion?

A. Yes.

Q. Doctor, when he first activated the battery, what was used to activate it?

A. He states that he filled it ¼ inches from the top [fol. 331] with water and allowed activation for fifteen minutes. In other words, he water-activated it, and later he added an electrolyte, magnesium sulphate.

Q. Why did he say he added the magnesium sulphate?

A. He was interested in reducing the internal resistance by one method that he knew, namely, adding ionization material to the electrolite.

Q. He said:

> "A little magnesium sulphate was added to counteract polarization about the positive electrode."

Does this show Shorr appreciated what he was doing?

A. Yes, but it was also something which he could find in the Adams patent.

Q. Doctor, would you continue at the point where I interrupted you?

A. He made further magnesium cuprous chloride batteries and he reached an open circuit voltage of 1.7 volts

and a short-circuit amperage of 0.5 amps, and he allowed them to activate, and then he said that he could not apparently get current, and the batteries as constructed were considered as having no capacity.

In his notes on page 4, December 6, 1943, he analyzes his results, and he says:

> ". . . the failure of any current to be produced [fol. 332] in the . . . cell is undoubtedly due to the internal resistance of the system. This resistance stems largely from the electrolyte which is mainly a dilute aqueous solution of magnesium sulphate."

He then tries to prove this, and he used a saturated solution of potassium chloride and one-half gram of magnesium sulphate. He then gets an open circuit of 1.55 volts and a flash amperage of 2.5 amperes.

He says:

> "The test is indicative that the resistance offered by the electrolyte may be overcome by adding an ionizable salt such as KCl."

He next tested a group of electrolytes as of December 8, 1943, and then on December 13th, on page 6, he did further work on it, and he plotted a voltage curve, which is approximately linear over a period of a little over one hour, and he says that the cell failed because the magnesium was depleted.

Then he proceeds on page 7 to make further cells. In Cell 1 he plots a voltage, and then makes further cells and discharges these at 150 milliamperes, and discharges these after one-half hour activation, and then continues to make further cells on page 9, and at the bottom of the page he talks about ampere hour capacity as 1.05 ampere hours.

[fol. 333] Q. What does that mean, Doctor?

A. It means that he is now rating the cells.

Q. He is now beginning to rate the cell electrically?

A. He is now beginning to rate them electrically.

On page 10 he describes Cell No. 4 and says that the magnesium was not clean at this time but it had a layer

on it, and he says that the decomposition production was most likely magnesium chloride.

He says:

"On cleaning the surface, the cell was rejuvenated."

And he records the voltage as 1.48.

On page 11, December 23, 1943, he talks about another cell, Cell No. 5, and in this cell he stated:

"This cell is similar to Cell No. 4, with the exception that the CuCl electrode was covered with several turns of absorbent paper"—and he says:

"As the electrolyte evaporated, the voltage dropped accordingly and rose on the addition of further electrolyte."

Q. Doctor, on this cell is there something placed between the cuprous chloride electrode and the magnesium electrode, at the top of the page?

A. He says:

[fol. 334] ". . . several turns of absorbent paper," and he is now beginning to use a spacer.

On December 30th he talks about Cells 6, 7, 8 and 9, and their activation and their discharge rates, and the activation time was 15 minutes and they were discharged at 150 milliampere rate to a cut-off voltage of 0.5 volts.

Here the rate consists of the material weight in grams per ampere hour.

He reports the voltages on these, and he reports the ampere hour capacity in grams of cuprous chloride per ampere hour and the grams of magnesium per ampere hour.

Q. That is on page 13?

A. That is on page 13.

Q. Could I ask you on this page, are these volts here as to the capacity and the figures in grams, are these satisfactory figures so far as the battery is concerned?

A. Given a specific application, they may be highly useful. They may not be the maximum performance.

On page 14 he is discussing Cells 10 and 11, the magnesium electrode and the cuprous chloride electrode, and he is again using there a discharge rate of 150 milli-

amperes, and he has plotted his voltages, and is using a cut-off rate of one-half volt, and he even changes the electrodes in Cell 10.

[fol. 335] Q. How did he do this, Doctor?

A. In Cell 10 the electrodes were taken out of the cell and washed in water and then dried by wiping with blotting paper.

On January 3rd the electrode had been replaced and the battery discharged continuously at 150 milliamperes.

He again shows the grams of cuprous chloride per ampere hour and the grams of magnesium per ampere hour.

On page 16 he studies the effect of the addition of mercuric chloride to magnesium chloride of different concentrations.

On page 18 he states:

> "Results recorded above indicate that a cell with good discharge characteristics and capacity could be obtained from the cell system, namely, Mg/M/$_2$ $MgCl_2$/CuCl."

Q. Doctor, may I ask you where have you seen that system before?

A. It is the system in Adams, where he says you can add magnesium chloride.

Q. He has said that?

A. Yes, sir.

He writes down what he believes are the cell reactions, and he tests the electrolyte.

[fol. 336] It is interesting to note that Shorr, as you will remember in testing the water this morning it was pH 6, and using the acid paper, which is similar to this type of paper he employed.

He did further work to reduce the temperature of the cell, because the reaction drops in reference to the increase in temperature.

Q. Doctor, on page 19 we have learned about the pH. Doctor, was that pure distilled water?

A. I do not know about pure distilled water, but the term is "distilled water," and it is assumed to be pure at pH 6, but the cell showed 4, which he characterized as

strongly acid, and he tried to eliminate the acidity by adding di sodium hydrogen phosphate.

Now he continues and further attempts to reduce the temperature of the reaction, and he does it by immersing the magnesium in potassium hydroxide, and by the addition of salts, and then he tries to make a cell with a solid electrolyte, on page 21, similar to a dry battery. In addition, he puts the magnesium chloride into a cornstarch paste, and he sets it up and discharges, and the temperature was high enough to bake the starch.

Then he tried sodium bicarbonate as an electrolyte, and then on page 22 he says:

> [fol. 337] "In all of the above tests showing high heating effects, the temperature would have risen still higher but for the fact that in each case the electrolyte dried out before the temperature could reach its maximum."

He reports a temperature as high as 187 degrees Fahrenheit.

On page 23 he runs still further tests and he adds, among other things, potassium dichromate, and says that the temperature held fairly constant but the voltage in the cell was low.

On page 24 he goes to the system of zinc-cuprous chloride, and he now reverts on page 25 to magnesium, magnesium chloride, plus water and cuprous chloride, and here he states under the conditio which he used that he added carbon, and that the temperature was maintained within very reasonable limits.

Now he combines cuprous chloride with carbon and cuprous chloride with manganese, dioxide with magnesium and magnesium chloride and magnesium and water, on page 25.

Q. Doctor, before you leave that page, would you note for the record in the second paragraph on page 25 how he got the carbon?

A. It was as if it was an electrode which he pressed [fol. 338] against the cuprous chloride.

Q. On the outside?

A. On the outside. Referring to these cells on page 26

and on page 27, he made three more cells where he added manganese dioxide and used that in connection with cuprous chloride and copper oxide with cuprous chloride, and he had the cell separated, which was magnesium-water-cuprous chloride without carbon.

He plots the voltages, and it is interesting to note on the voltages, if anything can be said about the voltage I think it is better than the other two. So that the temperature did not rise excessively, and he still discharged at 150 milliamperes.

Now he is talking about the minimum voltage for the cell, and beginning to think in terms of applying the techniques of design.

Q. Doctor, would you say that up to this point he has produced successful cells for the cuprous chloride-water system?

A. They are not successful but he has produced cells of the electrochemical system which work and they certainly would have some application which had been satisfied before.

On page 28 he determines the ampere hour capacity and says:

> "To determine the ampere-hour capacity of two

[fol. 339] cells whose electrodes were made as closely as possible."

And he now puts the magnesium in a cylinder, in which the cuprous chloride fitted closely, and it was made as made before, by heating and pouring it into a mold, and he used distilled water, and he says:

> "The cells are to be discharged at 70° F (50% humidity) at a constant drain of 150 miliamperes to 0.90 volts and a cut-off voltage of 0.5 volts."

He plots the voltage, and after the discharge he opens the cell, or the cells were opened, and the electrodes examined, and there was sufficient material to enable the cell to run for another six hours.

It says that though the cells were moist there was no longer any free water bathing the electrodes.

Then getting away from the magnesium-cuprous chloride system, on page 30 he stated that he took other systems with magnesium, and that the magnesium and lead electrodes were cut to the same size, and he does not plot the voltage curves. He goes back to the cuprous chloride system on page 32, and then leaves it again, and in a few cases plots voltage curves, but finds they are still too low. He has some magnesium with lead, lead oxide, magnesium-chloride and lead peroxide potassium [fol. 340] chloride, and what looks like Fe Cl, which I take to be ferric chloride, lead and lead peroxide, and then he goes to a series of zinc systems on page 36, some of which he discarded very rapidly, and others on which he plots voltage curves, but most of which has a short running time for testing, and then he stopped.

He continued to do this on pages 38, 39 and 40, obtaining all of his low voltages, and the results did not achieve anything further.

On pages 41 and 42, with cuprous chloride and other materials, such as lead peroxide and copper oxide, he deals rapidly with several cells, and then on page 44 he runs a single cell with amalgamated zinc and 30 per cent sulphuric acid, lead and lead peroxide, and he plots the voltages.

Finally on page 47 he comes to a radiosonde battery of the Kollsman Instrument Division, on which he runs a voltage curve and tells how the battery was activated through 68.0 volts, and he labels the battery "Battery No. 1," but gives no further data.

On page 48 he identifies the system as Radiosonde Battery, "Battery No. 2," and it is marked as having been made of zinc with 30 per cent sulphuric acid, lead and lead peroxide, and now he plots the voltage. He gives the result of that and he sets up a similar system on page 49 [fol. 341] in one of the voltage curves, and the voltage falls off very rapidly in both cases, that is the commercial cell and the other one which he made is shown on page 50.

Now on the end he has a bunch of charts and he plots Cell No. 10 which shows a magnesium cuprous chloride cell with an electrolyte containing one mole of magnesium chloride.

He plots the voltage against time and here are the

characteristics that we have been talking about earlier. It starts low and rises and has a curve change on it, and then becomes flat and constant over a period of time, which Shorr shows from the first to approximately the seventh hour on his coordinates. In other words, it is flat for six hours. He plots one on No. 9, and that is not given a flat curve, and it had a magnesium salt base.

Q. Doctor, on Curve No. 10, you mentioned the Kollsman Instrument Division, Battery No. 2, on page 48.

A. Yes, sir.

Q. What are those batteries used for, Doctor?

A. They are used to power radio-sending equipment, things like meteorological balloons.

Q. In other words, this would be the kind of battery that you would want a good low temperature operation for?

A. Yes, sir.

Q. Doctor, have you already plotted the figures?

[fol. 342] A. I have already plotted those figures for those two batteries on my chart 10.

Q. Thank you, Doctor.

You have plotted there, have you, the figures with respect to these two batteries?

A. The figures for the commercial one and just Battery No. 1.

Q. And Battery No. 2 on the next page?

A. Battery No. 2 on the next page.

Q. On pages 47 and 48?

A. On pages 47 and 48.

Q. You have plotted the curves for the two commercial batteries against the test battery on No. 10 curve?

A. Yes, sir.

Q. Would you turn to that and tear that page out of the book, please?

A. (Witness complies)

Q. It is a comparative performance of two commercial batteries, Doctor, intended for low-temperature operation against the performance of one experimental cell of the magnesium - cuprous chloride - magnesium - chloride-water system?

A. Yes, sir.

Mr. Reilly: I would like to ask to have this identified and received in evidence as Plaintiffs' Exhibit No. 38. [fol. 343] Permit me to review my notes for a minute and then I will be ready.

(Discussion off the record.)

Commissioner Lane: Back on the record.

Mr. Arseneau: No objection.

Commissioner Lane: Plaintiffs' Exhibit No. 38 is received in evidence.

(One-page chart headed Cell No. 10 was received in evidence as Plaintiffs' Exhibit No. 38.)

Commissioner Lane: We will recess now for ten minutes.

(Short recess.)

Commissioner Lane: You may proceed, Mr. Reilly.

Mr. Reilly: Thank you, Your Honor.

By Mr. Reilly:

Q. Doctor, I will show you a copy of Trial Exhibit No. 12, pages 75 to 78.

Commissioner Lane: Let me interrupt you before you go on, Mr. Reilly. I want to ask Doctor Mantell a question about the symbols on Trial Exhibit No. 12, and I note on the page to which you have referred that in some places there is a symbol CuCl, and other places I see Cu_2Cl_2, and still other places I find $CuCl_2$.

I think you might explain those symbols for cuprous chloride and cupric chloride so that we will have it correct [fol. 344] in the record.

The Witness: First, Your Honor, the cuprous ion is monovalent. It has one charge, and chlorine is monovalent and it has one charge. All the symbols for cuprous chloride are to balance the valence, one being plus and one being minus. The combination being CuCl. However, a number of compounds in connection with what we term their molecular weight, the simplest combination, as shown by their reaction in solution, may indicate that the com-

pound formula is not the simple ratio but it might be 2 to 2, rather than 1 to 1. In the early work on cuprous chloride there was some evidence that the formula should be Cu_2Cl_2. Currently there has been enough additional work so that we believe the formula should be CuCl, but they are essentially the same formula in terms of the ratio of the chlorine and copper.

Now cupric copper has a valence of 2, and therefore, if it were combined with chlorine, having a valence of 1, it would require 2 of chlorine, and therefore $CuCl_2$ is cupric chloride, which is appreciably different in solubility in contrast with cuprous chloride, which has a solubility at six points to 100,000.

Commissioner Lane: Thank you.

By Mr. Reilly:

Q. Doctor Mantell, please refer to Trial Exhibit No. [fol. 345] 12, pages 75 to 78.

A. Yes, sir.

Q. Doctor, I will call your attention to the fact that this is a report from the Squier Signal Laboratory, Battery Branch, Fort Monmouth, New Jersey, dated 28 July 1948, and signed by Nicholas Wilburn, concerning two pages of information and two photographs.

A. Yes, sir.

Mr. Reilly: Your Honor, are your copies and the photographs legible? Let me show you mine, which is Zeroxed, and at least for the moment you can look at it.

By Mr. Reilly:

Q. First, Doctor, is there a battery before you which resembles the one shown in the two pictures?

A. Yes, sir. I believe it is Plaintiffs' Exhibit No. 29.

Q. Plaintiffs' Exhibit No. 29?

A. Yes, sir.

Q. Thank you.

Now, Doctor, I will ask you, have you examined this report, Trial Exhibit No. 12, pages 75 to 78?

A. Yes, sir.

Q. Will you explain it, please?

A. In general my reaction to the report, having seen

[fol. 346] this exhibit and having seen the batteries, my reaction is that there appears to be some kind of disconnection or electrical opening, and the same thing might have happened in this case, in the report on the test cell, because I find that it says that when the system is employed it would give higher amperage and voltages than this, and if there is a break in the electrical circuit, it would give current, power. Whether that has happened in this report or not, I do not know, but I would suspect that that was the situation.

Q. Doctor, would you just refer to page 2 of the report and look at the voltage column, particularly the final open circuit voltage, and comment on what is shown there, please?

A. The final open circuit voltage appears to be normal, and the initial open circuit voltage seems to be fairly normal to a point in activation. However, we have found in experimentation with batteries, if we get them open and sometimes get a contact and then do not get a contact, we will have results like this.

Q. In other words, Doctor, the final open circuit voltage of 1.56 is something that possibly could occur when the circuit is closed? Is that correct?

A. Yes, sir.

Q. I mean the electrical contact was established.

[fol. 347] A. The electrical contact was established.

Q. And in the prior voltages, at least five above it, there was some lack of continuity, is that right?

A. Some lack of continuity or maybe an electrode broke.

Q. Doctor, when we were playing with these two batteries this morning, do you recall at one point that the battery which is physically on your left, the one made with water, the melted cuprous chloride cathode, began to flicker and go out?

A. I do. We checked the connection, and that apparently was the trouble.

Q. Is that what you are postulating might have occurred in this test report?

A. Something might have happened similar to that.

Q. Thank you very much, Doctor.

Doctor, is there anything in this to indicate that Mr.

Wilburn was in any way familiar with Mr. Shorr? Do you find any mention of Mr. Shorr in here at all?

A. There is no mention of Mr. Shorr or any indication that Mr. Wilburn was acquainted with Mr. Shorr's work.

Q. Do you find any indication in here, Doctor, that Mr. Wilburn, on the basis of this had ever had any conversations with Mr. Adams or had any information from him, other than what appears there, except for the visit re- [fol. 348] fered to in this specific exhibit?

A. There is no indication that Mr. Wilburn knew Mr. Adams, except as referred to in connection with this particular visit.

Mr. Reilly: Now, Your Honor, I would like to refer to what I believe is Commissioner's Exhibit No. 4 and Commissioner's Exhibit No. 3, which I am sure we have a copy of.

I am going to summarize some of the material on the record, and then I am going to ask some technical questions of Doctor Mantell.

As I understand it, this material—and I would appreciate it, Mr. Arseneau, if you would correct me if I am mistaken—apparently an Italian sea lamp for life belts, was captured possibly in 1943, if I can read this photostat correctly. At any rate, a contract was let to Thomas A. Edison, Incorporated, to make batteries like this Italian sea cell which was captured.

Then at some subsequent date, in 1945, some report and test was made of these cells. I regret that I can't summarize the work more accurately than that, except I will say that the contract is Commissioner's Exhibit No. 3, and the remainder of this material, which I have not had a great deal of time to study, is Commissioner's Exhibit No. 4.

I am going to ask the Doctor some questions concerning [fol. 349] the battery.

By Mr. Reilly:

Q. Doctor, I have before me one copy only of Commissioner's Exhibit No. 4, and I turn to the first two pages, which are a letter from Thomas Edison to some-

body, and there are two pages of photostats and a drawing which is labeled "Italian Electric Lamp for Life Belts." In so far as you are able, will you describe the structure of whatever battery is involved in that device?

A. In the Scientific Division Informal Report, with reference to the Italien Electric Lamp for Life Belts, there is a description which says:

> "The cell consists of a central positive electrode of fused cuprous chloride in the form of a cylinder 1.8 cm. diameter and 10 cm. high, weighing 100 grams. Embedded in the cuprous chloride is a spiral strip of copper foil attached to a copper wire which is brought out at the top as the electrode connection.
>
> "The negative electrode is a sheet of magnesium metal about 1.7 mm. thick bent into a cylinder 10 cm. high and 3 cm. internal diameter surrounding the positive pole."

Inasmuch as that was 1.8 cm. in diameter and the other 3 cm. in diameter, the other one fits into it, and the [fol. 350] weight of the magnesium is about 30 grams, and the lead from the magnesium is a copper wire attached by means of a copper rivet. The lead is also attached to the aluminum case by a copper rivet.

Without reading it, the magnesium is coated with a gray paint no doubt for protection in storage.

Then it states:

> "The two electrodes from a sea cell on immersion in sea water."

And the statement is made that the aluminum does not enter into cell reaction at all.

If you look at the diagram, which is labeled "Italian Electric Lamp for Life Belts," the bottom part is the cell and the top part is the chamber and lamp. There is a standard positive electrode (cylinder of cuprous chloride) and negative electrode (cylinder sheet of magnesium metal), and aluminum cell case. Then it says lower molded electrode separator—I guess that is what it says but I can't read it very well. It might be "bolted electrode separator."

There are contacts of the cuprous chloride electrode leading to the lamp, and there is a contact worked through to the magnesium case, through the lamp, and there are separators in between. This is the electrode system, magnesium-cuprous chloride, and sea water is the electrolyte, [fol. 351] and it is the Adams system.

Q. Doctor, looking at the physical arrangement of the battery which you have testified from, is the physical arrangement of the battery like the drawing in Adams?

A. Yes, sir, so far as the battery portion itself is concerned.

Q. That is what I am referring to. Will you look at the next page, Doctor, and tell me what that is, if you can?

A. Yes, sir.

Mr. Reilly: Mr. Arseneau, will you tell me, is the next page labeled "Thomas A. Edison, Inc., Primary Battery Division, Bloomfield, New Jersey"? And is that the battery that the Edison people made under this contract which is Commissioner's Exhibit No. 3?

Mr. Arseneau: Let me do this: Let me refer to the blank portion of the Edison Company letter which says:

> ". . . Thomas A. Edison Industries of the McGraw-Edison Company participated in the production of a Type 844 Sea Water Battery in 1944 and 1945."

There are indicated designations on the print, and these are enclosed, and I do not want to vouch for it.

Mr. Reilly: Is there any designation in this material as to how that battery is made? There seems to be a differ- [fol. 352] ence in the material which I have in my copy and the material which you have in your copy, starting at the front.

Commissioner Lane: Let us go off the record.

(Discussion off the record.)

Commissioner Lane: Back on the record.

By Mr. Reilly:

Q. The next document, Doctor Mantell, as I understand it, looking at the drawings of Edison on this subject—the next document I believe is the Thermofax copy to which Mr. Arseneau referred off the record, which is the report of the Naval Research Laboratory, at the Anacostia Station, concerning the automatic flashing lantern, and also the behavior of the manufacturer's first models of this device, that is of the automatic floating lantern-life saving. "These units were assembled by the Delta Electric Company, makers of the small floating light assembly, while the batteries were made by the T. A. Edison Co., Inc., Primary Division. The tests were made at this Laboratory" and so forth.

By Mr. Reilly:

Q. Doctor, if you can go through the copy, can you find the test reports and tell me how these batteries operate?

A. This was a four-cell battery, "made up of cuprous chloride positives and magnesium negatives, mounted in the lower end of a metal cylinder at the top of which was [fol. 353] a small light bulb. These units were not uniform in size but in general were about 3 inches in diameter and 20 inches long. Each unit was so weighted that it would float in sea water with about the upper five or six inches exposed."

Table 1 reports the voltages, which at the beginning were 4.8, and then rose to 5.8, with the amperage, beginning at 0.139 and going to 0.155, and finally climbing to about 0.160, and then dropping to 0.158, and showing a flat type of amperage curve, and that voltage curve is similar in each one of the bulbs, and the voltages run from 4.8 to 5.85, and the amperages are similar. The curves show a rise and then no further results are reported.

Q. You are referring to page 2, Doctor, of the Naval Research Laboratory letter?

A. Yes, sir.

Q. Doctor, do these results appear to represent operative battery structures?

A. Yes, sir. It is interesting to note that Unit No. 5 did not function. One unit of the light bulb was burned.

Q. I refer you to Paragraph 7 of that letter concerning low temperature tests.

A. That means that no low temperature tests were made but that "the behavior of a battery of this type is not far different at 2° C. from that at 22° C."

[fol. 354] It is difficult to state whether that is "2" or "20" or "28."

Q. Doctor, to help us out, in this letter of the Naval Research Laboratory, three lines from the bottom, would you read what it says as to how the positives were made?

A. (Reading) "The positives were made by casting cuprous chloride on a copper screen grid."

Q. Doctor, is there any mention in there of production difficulties?

A. No.

Q. Doctor, will you refer to the drawings, Plates 1 and 2 following the letter?

A. Yes, sir.

Q. And would you comment on them?

A. These are curves of cell voltage, and in Plate 1 the voltage is constant, or almost constant, there being a very slight rise in it for about 22 hours, and there is a note at one point, "Light Bulb Burned Out," and this is Unit 4 and Unit 1, and the curves in the main on the flat portion are somewhat superimposed.

In Plate 2 there are similar voltage curves plotted, and the statement there says:

> "Each Cell has 3 CuCl Positives and 4 Mg Negatives—Discharge Rate=0.2 amp."

[fol. 355] And the voltages are plotted, and they show at 2 degrees that the curve is not quite as flat, and is below the 22-degree curve, which is reasonably flat and thinner for some two hours to approximately 22 hours, in other words for 20 hours, while the two-degree C. voltage curve is somewhat flat from about four hours to about sixteen hours, a total of twelve hours.

Q. Doctor, I notice the statement on page 2 to which you have referred, stating that the "other tests made at this laboratory indicate that the behavior of a battery of

this type is not far different at 2° C. from that at 22° C."

Referring to Plate No. 2, is that a substantiation of that statement on page 2?

A. Yes. If I assumed that the curve with two degrees means—that is the figure that I had difficulty in reading, the two degrees, then there is no marked difference as stated in the report.

Q. Doctor, is the structure which you find on the drawing of the Italian Electric Lamp for Life Belts, and the information given on that drawing markedly different than the information concerning the battery that Adams gave to the Government?

A. It is quite the same.

Q. You find this battery to be operative?

[fol. 356] A. At lower temperatures than this.

Q. Doctor, would you refer to the following section of this document, which is entitled "Naval Research Laboratory Report"?

A. Yes, sir.

Q. And would you go through it, Doctor, and then tell us your comments?

A. In the abstract of the Naval Research Laboratory Report of November 1945, entitled "A Brief Survey of Various Sea Water Cells," by T. P. Dirkse, Report P-2711, there is a statement:

> "A brief survey has been made of various types of primary cells which use sea water as the electrolyte. Several such cells were constructed, some of which were made in accordance with directions given in the literature.
>
> "Of the combinations tried, the silver oxide-magnesium and cuprous chloride-magnesium cells gave the best results. These cells give a fairly steady voltage and this voltage does not change greatly with a decrease in temperature. With the cuprous chloride positives there is a dip in the discharge voltage curve immediately after the discharge begins. The silver oxide positives do not show this [fol. 357] behavior. The silver chloride-magnesium cell also functions well with sea water but its discharge voltage is not as high as that of the silver

oxide-magnesium cell and it requires twice as much silver for the same amount of electrical capacity."

On page 2, paragraph 7, there is a description of the cell having cuprous chloride positives, magnesium sulfate and magnesium chloride as electrolyte, and that this cell was tried with sea water as the electrolyte.

Then it states:

"Several cells were made, each having three cuprous chloride positives and four sheet magnesium negatives. The size of the plates was 1½ inch x 1½ with a thickness of 1/16 inch. The positives were made by pouring molten cuprous chloride into a mold which contained a 40 mesh copper screen. This screen served as the grid. The total weight of the plates in each of these cells was about 65 grams. These cells were discharged at different temperatures and some of the results are shown on Plate 4."

Before we move to Plate 4, Paragraph 9 says:

"A similar type of cell is described in reference (g). Apparently this cell was used by the Italians in some sort of floating lantern also."

[fol. 358] Q. Doctor, let me ask a question on Paragraph 7, if I may. It states:

"The positives were made by pouring molten cuprous chloride into a mold which contained a 40 mesh copper screen."

Anywhere in what you have been able to look at so far, in the description of making the positives in this Government document of the Naval Research Laboratory, have you found the word "fused"?

A. In the specific reference to the formation of the cuprous chloride positives, the statement is made that they were formed by pouring cuprous chloride into a mold.

Q. Thank you, Doctor.

You did not find the word "fused"?

A. So far I have not found the word "fused."

Q. Doctor, will you look at the back of this brochure for a moment and see if you can find Reference (e)?

A. Reference(e) is U. S. Patent No. 2,322,210.

Q. Is that shown on page D?

A. That is shown on page D under the references.

Q. Thank you, Doctor.

That is the patent in suit.

Now, Doctor, will you see if there is any more information in which we are interested in this report concerning [fol. 359] these types of cuprous chloride magnesium systems?

A. The statement is made:

> "These cells were discharged at different temperatures and some of the results are shown on plate 4. The discharge voltage of this cell is not greatly affected by a change in temperature from 22° C. to 3° C."

They talk about cells, such as these made by Thomas Edison, and that that one came up to its peak value rapidly.

On Plate 4 there is plotted the cell voltages of sea cells, and the dimensions are given there, being three positives and 4 sheet magnesium negatives, and there are three curves. Curve A is the cuprous chloride positive with magnesium at a temperature of 22 degrees Centigrade, and that shows a rise, and that at approximately in the second hour it came to its peak voltage, and it maintained that peak voltage for approximately 20 to 22 hours on the chart, which means that it has held it for 18 hours.

Q. Is that Plate 4, Doctor?

A. That is Plate 4, and it is also labeled "Plate 4-P-2711."

The B curve shows a three-degree temperature for cuprous chloride positive, on a sheet of magnesium, the electrolyte being sea water, and that one comes up for all [fol. 360] substantial purposes to its voltage in about three hours, and runs until about fifteen hours, which would be twelve hours, and it has a flat section.

The C curve, shown at the bottom, is for copper oxide positives for magnesium, and that shows a relatively rapid

decreasing voltage, with only a short-time period before it is flat.

Mr. Reilly: Very well, Your Honor.

Commissioner Lane: Do you want to recess until tomorrow?

Mr. Reilly: I think so, Your Honor. I returned Mr. Arseneau's copy to him.

Commissioner Lane: Before we go off the record, I might observe that the solutions in the two demonstration samples seem to have lost their color.

We will recess now until 10:00 o'clock tomorrow morning.

(Whereupon, at 4:50 o'clock p.m., Wednesday, July 12, 1961, a recess was taken until 10:00 o'clock a.m., Thursday, July 13, 1961.)

[fol. 361] **Transcript of Testimony for Plaintiffs and Defendant—July 13, 1961**

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[fol. 362] Commissioner Lane: You may continue when you are ready, Mr. Reilly.

Mr. Reilly: Thank you, Your Honor.

Mr. Arseneau, did you obtain anything on the silver chloride battery?

Mr. Arseneau: I will make a statement on the record now. I checked the transmittal of information showing what was obtained during the six-year period and I find it is not characterized one way or the other as "fused."

Mr. Reilly: Does it tell how it was made in step terms?

Mr. Arseneau: No, it does not. This correspondence simply places us on notice that this type of trial exhibit is illustrative of what was employed during the six-year period preceding the date of the filing of the Petition.

Mr. Reilly: In that case I will ask the witness to make certain assumptions concerning alternative constructions of cathodes.

WHEREUPON CHARLES L. MANTELL, the witness on the stand at the taking of the recess, resumed the stand and testified further on behalf of the Plaintiffs, as follows:

Direct examination (Cont'd)

By Mr. Reilly:

Q. Doctor, referring to this silver chloride battery [fol. 363] which was identified yesterday as Trial Exhibit No. 18, I will ask you the following questions:

Doctor, is Trial Exhibit No. 18 a battery?

A. Yes.

Q. Does it contain a liquid container?

A. Yes.

Q. Does it contain a magnesium electropositive electrode?

A. Yes.

Q. Doctor, is the magnesium electropositive electrode in the container?

A. Yes, sir.

Q. Does one of the magnesium electropositive electrodes have an exterior terminal?

A. Yes, sir.

Q. Does it have a silver chloride electronegative electrode?

A. Yes.

Q. Is there a terminal connected with said electronegative electrode?

A. Yes.

Q. Doctor, assuming that the silver chloride electronegative electrode is made by a process involving the liquefaction of silver chloride and a subsequent pouring and molding operation, or a subsequent forming, molding [fol. 364] and rolling operation involved in either before or during the process of solidification, could you relate the steps of the process which I have just described to the steps such as we had on the Adams structure and such as we had with respect to Fischbach?

A. It would be only related, and it would end up in the unified structure.

Q. Would a mixing operation be involved?

A. I would so expect.

Q. Would a blending and liquefaction step be involved?

A. Yes.

Q. Would a forming, molding and shaping step be involved?

A. Yes.

Q. Would a solidification step be involved?

A. Yes.

Q. Now, Doctor, supposing the electronegative electrode, the silver chloride one, was made by electrolysis, would you describe for us the electrolytic operation?

A. In the electrolysis the constitutents, one or more, would have been liquefied, and after the liquefaction they would be precipitated from the electrolyte, and would thus be subjected to removal from the electrolyte or water, and the result would be a unified structure.

[fol. 365] Q. There is a liquefaction phase?

A. There is a liquefaction phase.

Q. Is there a solidification phase?

A. There is a solidification phase in the act of precipitation.

Q. And the net result of the process is to produce what you term "a unified structure"?

A. "A unified structure."

Q. In which the silver chloride is in one piece?

A. Yes.

Q. In the electrolytic process, does the process result in the deposition of a uniform layer of the silver chloride?

Mr. Arseneau: I think I will object to this, Your Honor. There is a lot of confusion in my mind as to who is testifying. I believe that counsel should question the witness in less leading fashion.

Mr. Reilly: I will try to, Mr. Arseneau. I have never tried a case before, frankly speaking, where this situation obtained, where there is a battery which the Government does not know how it was made in contractors' plants. I was told when working for the Government that the Government inspector of material knew every step of every process that went into the construction of every [fol. 366] article purchased by the Government, but I will try not to lead Doctor Mantell.

Commissioner Lane: Very well.

By Mr. Reilly:

Q. Doctor, on the electrolysis, is there a forming or molding step that in any way affects the dimensions of the final product?

A. There is.

Q. When the electrolytic process is begun, Doctor, is there a solution involved?

A. There is.

Q. How is the solution made up?

A. It will be made up either of ions, which are within the silver and converted into silver chloride, or it might be in one modification silver chloride dissolved in a solvent and electrolytically precipitated therefrom.

Q. Silver chloride dissolved in a solvent?

A. Yes, sir.

Q. What is the first step in that process?

A. The first step is to dispose of the silver chloride the way you want to, as a solid.

Q. Now going back to the liquefying step, how was the solution prepared?

A. The solution is made up either from a salt of silver or silver chloride, in a solvent, hidrochloric acid, or [fol. 367] other chlorides.

Q. Is there a mixing step involved?

A. There is a mixing step involved in the formation of the electrolyte.

Q. Doctor, are you familiar with the report published in the Transactions of the Electrochemical Society, pages 529 to 554, and authored, according to the first page thereof, by Mr. J. B. Mullen and P. L. Howard?

A. Yes, sir.

Q. Doctor, what does this article concern itself with?

A. Its title is "Characteristics of the Silver Chloride-Magnesium Water Activated Battery," by J. B. Mullen and P. L. Howard, who are indicated as being from the Burgess Battery Company, A. M. Battery Division, Antioch, Illinois.

It starts out by saying:

> "At the beginning of the war, a serious need arose for extremely light weight, small size, high powered

batteries. This was necessitated by the many advances in electronic equipment for the Armed Forces. The storage batteries and dry cells were either too large or did not have the desired capacity to meet the demands of the new light weight and small size electronic equipment. Early experience showed that an in- [fol. 368] definite storage life was necessary for batteries to be used in all parts of the world."

That refers to temperature extremes and the like.

Q. Doctor, what is the substance of the remarks in the second paragraph, and I wish you would comment on the second paragraph of this document.

A. In the second paragraph there is a discussion of the use of silver chloride as a depolarizer, with the remark that it had not "been exploited further than use as reference electrodes and one type of voltaic cell. This cell was of the pasted silver chloride-zinc type made similar to the Leclanche dry cell."

Q. Is there any comment concerning the effectiveness of that type of cell?

A. (Reading) "Probably the main reason for lack of exploitation was due to low voltage of 1.0 volt per cell and low ampere discharge rates. No work had been done on use of other negatives such as magnesium to increase the voltage of such a system and render it more widely useful."

Q. Doctor, may I interrupt to ask you, had it ever been suggested in the art, prior to that, to use magnesium in primary cells?

A. Very many times, largely from the theory aspect, but always with the thought that magnesium was easily [fol. 369] corroded, and that it might not be readily possible to control the rate of reaction with magnesium, once started.

Q. Doctor, will you continue your description of this article, please?

A. Mullen and Howard state:

"This study was undertaken to develop a cell which would have these properties:

"(1) As high a voltage as possible, preferably at least 1.5 volts per cell.

"(2) Long storage characteristics, preferably indefinite by long storage."

I think instead of the use of "indefinite," they might also have used the word "infinite."

(Continuing reading) "(3) Low weight per watt-hour output.

"(4) Ability to deliver its energy rapidly, that is, at high currents."

Then the statement is made:

"Silver chloride and magnesium were selected as components, after testing numerous other couples, because of the interesting combination of excellent deplorarizing action and high voltage."

Q. Doctor, do you know another system which has the same things?

[fol. 370] A. It is rather one system, with magnesium-cuprous chloride and magnesium-silver chloride.

In the discussion of the design of construction, the statement is made:

"To achieve the objectives outlined above, the silver chloride-magnesium battery was developed as a reserve type battery with the electrolyte to be added just prior to use. A compact, simple, and efficient design of spirally wound cells was developed which is used in batteries with capacity over about five ampere minutes. The positive electrode of each cell consists of silver foil, 0.001 in. (25 microns) to 0.003 in. (76 microns) thick, coated with electrolytically formed silver chloride on both sides, with wire leads welded on."

Again, Your Honor, the use of the language "positive" and "negative" is a little confusing because of the type of system.

Q. Did you say that it was silver chloride, Doctor?
A. Yes, sir.
Q. Proceed.

A. (Reading) "The negative electrode consists of commercially pure magnesium foil (supplied by Dow Chemical Company) of the same width, to which [fol. 371] a similar wire lead is welded. The two electrodes are wound spirally together, with dry absorbent paper interleafed between the two electrodes. This forms a cylindrical cell with wire leads at the ends. The cell thus formed in its dry condition is completely inert and will keep indefinitely. The absorbent paper is an effective barrier between the silver chloride and magnesium electrodes. When saturated with an electrolyte, the absorbent paper becomes a conductive medium and the cell can be discharged through a suitable resistance."

Q. Doctor, Let me ask you this: On the paragraph which you have just gone through, are we talking about batteries?
A. We are talking about batteries.
Q. Did you find in that description of the battery given there that there is a liquid container?
A. Yes.
Q. A magnesium electropositive electrode?
A. Yes, sir.
Q. Is there some reversal of terminology?
A. There is some reversal of terminology.
Q. The same type of mistake or thing that Adams used?
A. Yes, sir.
[fol. 372] Is there an electropositive electrode inside the container?
A. Yes.
Q. Does the electropositive electrode have an exterior terminal?
A. Yes, sir.
Q. Is there a silver chloride electronegative electrode?
A. Yes.
Q. Is there a terminal connected with the electronegative electrode?

A. Yes.

Q. Doctor, in the batteries we have just talked about, is there a combination of a magnesium electropositive electrode and an electronegative electrode, comprising silver chloride?

A. Yes.

Q. Thank you, Doctor.

What does it say, Doctor, and what are your comments concerning the remainder of the important part of this article?

A. There is further discussion in reference to design, concerning high voltage application, with respect to the total current output, and it says:

> "For high voltage applications, in which current [fol. 373] and total output are low, the batteries are probably made up in flat-cell form. . . . In such cells the silver chloride is formed on only one side of the silver sheet. Batteries are made up by stacking plates with absorbent paper between the electrodes of each cell and insulation between adjacent cells."

And it states further:

> "At the time of use, the battery is removed from the sealed container and is activated by immersion in common or salt water to saturate the absorbent paper. It may be discharged either after removal from the water, or while immersed continuously, i.e., in the case of low voltage batteries."

Q. In cuprous chloride batteries may they be discharged after removal from water or while immersed continuously?

A. Yes, sir.

> (Reading) "When tap water is used as electrolyte, the low initial concentration of ions causes a comparatively slow rise in voltage for the first few seconds; but chloride and magnesium ions are rapidly produced by the cell action, which increases the [fol. 374] conductivity of the electrolyte. Voltage ordinarily rises to nearly the peak within one to two minutes. If faster voltage is required, sea water or a

dilute salt solution is used to supply sufficient ions at the start."

Q. What sort of ions are those in sea water, Doctor?

A. In sea water it would be sodium ions, chloride ions, magnesium ions, sulphate ions, calcium ions, and bromide ions.

Q. Will you comment briefly on the test results and characteristics?

A. The following remark is made:

"One of the outstanding characteristics of the silver chloride-magnesium cell is the steady voltage obtained on discharge."

There is a reference to Figure 1 and it states:

"Fig. 1 shows the comparative shapes of typical discharge curves of Leclanche, perchloric acid, and silver chloride-magnesium cells."

And if you will look at Figure 1, curve 2 is the silver chloride-magnesium type, and it shows under these conditions of discharge the flat type of potential as compared to the falling potentials of the other curves. In other words, the curve is a linear potential.

Q. Doctor, let me clarify that. If you look at curve 1, one portion of it is fairly straight, is it not?

[fol. 375] A. That is right, and that might also be characterized as "linear," but it is not linear in the term that Adams used, and that the battery industry in general has adopted.

Q. In other words, "linear" in the opinion of the battery industry means level as well as straight?

A. Yes, sir.

Q. I understand, Doctor. Will you continue?

A. Yes, sir.

Q. I think that in the question which I just asked you I anticipated your comment because I notice a few lines further down it remarks about the characteristics of the perchloric acid discharge curve in these words:

"This cell, which is generally considered to have an approximately flat discharge curve, actually has a

slow, almost linear decline in voltage throughout its useful life."

That is what we have been discussing?

A. Yes, sir.

Q. Please continue.

A. We have already covered that.

(Reading) "In contrast to these, . . ." Referring to the other two cells.

". . . the discharge voltage of the silver chloride-magnesium cell actually rises somewhat at [fol. 376] the start, after which it remains nearly constant at about 1.5 volts on load for most of the life of the cell."

Q. Thank you, Doctor.

Can we go to your next comment, Doctor?

A. The statement is made:

"The silver chloride-magnesium cell will deliver an extremely high current at a useful voltage. This is not a matter of flash current on short circuit. . . ."

Q. What page are you referring to, Doctor?

A. Page 532.

Q. Thank you.

A. (Continuing reading) ". . . the high current can be delivered at 1.3 to 1.5 v./cell."

On the next page, page 533, there is this statement:

"While the silver chloride-magnesium cell is particularly adapted to production of high currents, it is not limited to this class of service."

Examples are given of low amperage and long time, the "long time" being a relative statement.

Q. Doctor, do you find that the cuprous chloride-magnesium cell has characteristics of the type which you have just mentioned?

A. Yes.

[fol. 377] Q. Thank you, Doctor. Continue, please.

A. On page 534 there is a statement about the silver chloride-magnesium system which states:

"These batteries are characterized by their low weight per ampere-hour or watt-hour output per cell."

I remember that earlier there were references to other curves throughout the article, and these are 2, 3 and 4, all of which are discharge curves, and all of which show the linear or flat type of curve.

There is a statement on page 535 as follows:

"While these batteries must be activated at temperatures at which water is liquid, once activated they can be operated at much lower temperatures."

There is a reference to Figure 7, and those are curves at plus 20 degrees and minus 40 degrees, both of them showing the type of flat type curve, and the difference between them is not substantial. The low temperature curve is the bottom curve of the two in Figure 7.

Figures 5 and 6 also make comparisons with other batteries, and in Figure 5 the middle curve is the silver chloride-magnesium cell, and the shape speaks for itself as compared with the others.

In Figure 6 the type of curve is the silver-chloride [fol. 378] cell.

There is a statement on page 538:

"Increase in current has only a slight effect on voltage. . . . Output in ampere-minutes is approximately constant except for highest current; but even here the decrease is only 15%."

Q. Doctor, do you find this characteristic present in cuprous chloride-magnesium batteries?

A. Yes, sir.

Q. Is this an important characteristic?

A. It is an important characteristic for specific applications.

Q. Thank you.

A. The conclusion of the article talks about the principal advantages of the silver chloride-magnesium battery, light weight, small in size, can be stored indefinitely, high terminal voltage under high and low discharge rates; change in temperature has little effect on output; and the

discharge voltage remains flat over the major portion of the discharge.

> (Reading) "A further advantage of the battery is that a special electrolyte is not required for its operation because it operates with any type of water (either fresh or salt)."

Q. Doctor, what other battery than the silver chloride-
[fol. 379] magnesium, if there is one, has all those characteristics?

A. Silver chloride-cuprous chloride.

Q. Do you mean the magnesium cuprous chloride?

A. Yes, sir, magnesium cuprous chloride.

Q. Doctor, do you know Doctor Ferguson?

A. Doctor A. L. Ferguson of the University of Michigan, and I have known him for a long time very well.

Q. Do you care to comment on the discussion and colloquy concerning Doctor Ferguson?

A. In the discussion following the paper Doctor Ferguson, who has spent almost his scientific life investigating electrode reactions and the like, asked the question:

> "I did not get the statement as to what was used as the porous material."
>
> And he was told that it was "just absorbent paper."

He skeptically asked:

> "You mean that there was nothing there but paper?"
>
> And he is told: "That is right."

Then he asked whether the cell would work in distilled water and apparently the way he asked the question caused the speaker to say:

> "Yes, it will. We will send you some cells to try," . . . so that he could convince himself.

Q. You are referring to the discussion on page 544,
[fol. 380] Doctor?

A. Page 544.

Q. Thank you, Doctor.

A. Yes, sir.

OFFER IN EVIDENCE

Mr. Reilly: I will offer this document, Your Honor, as Plaintiffs' Exhibit No. 39.

Mr. Arseneau: Your Honor, I have no objection to the receipt in evidence of this article, but providing it is done on the basis that the various process techniques of Burgess as disclosed are recognized as hearsay.

Mr. Reilly: I have no more information concerning the present-day characteristics of Burgess with respect to this article than any other information supplied here.

Commissioner Lane: It will be received in evidence.

(Photostat consisting of pages 528 through 545 from paper entitled "Characteristics of the Silver Chloride-Magnesium Water Activated Battery," by J. B. Mullen and P. L. Howard, received in evidence as Plaintiffs' Exhibit No. 39.)

By Mr. Reilly:

Q. Doctor, I refer you to Plaintiffs' Exhibit No. 18, which is the Burgess Brochure.

With the Court's permission, I will number the pages of this original, and I will run through them and then we can be certain that they run from front to back.

[fol. 381] May I do that?

Commissioner Lane: Yes, sir.

Mr. Reilly: Will you all do the same so that they will be correctly numbered?

I have numbered the Court's copy 1 to 8 pages.

By Mr. Reilly:

Q. Now, Doctor, if you will please refer to page 8 of Plaintiffs' Exhibit No. 18, I am going to read you two paragraphs, and I would like to ask your comment. I am referring to Paragraph 2, which states:

"Most Burgess Reserve Type Power Units are available in either silver chloride-magnesium or cuprous chloride-magnesium construction.

"The silver chloride-magnesium types are more

stable, have higher output ratings per unit volume, and are somewhat smaller and lighter than cuprous chloride-magnesium types having equivalent electrical characteristics."

Will you comment on that, please, Doctor?

A. I see no reason to question the accuracy of this or the truth of the statement, in that it has been repeated many times in the literature, not only by Burgess but by competitors and by research workers in the field, and by other people at the battery conferences of the Signal [fol. 382] Corps, and by members of the battery industry, and it is somewhat difficult to get hold of them to read them but they are all quite similar.

Q. Do you agree, Doctor, in your opinion, that silver chloride-magnesium types and cuprous chloride-magnesium types have equivalent electrical characteristics?

A. Yes, sir.

Q. Thank you, Doctor.

Doctor, just briefly what is the type of construction of batteries shown on pages 7 and 6, preceding the page we discussed?

A. On page 7 there are examples of the plate, either in stacks or piles, and on page 6 there is the concentric wound types or the wrap-around types.

Q. Is that also a plate with a round central cathode in it, such as the Adams' patent shows?

A. I do not quite understand the question.

Q. I'm sorry. Just looking at it as you see it on page 6, there is what looks to be like a round can, and I am asking as to whether the electrode there, or the central electrode, is a solid cylinder, or whether it is actually a plate type battery?

A. It is a plate type battery in the sense that it might be thought of as taking a long strip, another long [fol. 383] strip for the intermediate layers, then another long strip, and then rolling the thing up as you would a kind of pastry or a bun made that way.

Q. With a multiple of layers?

A. With a multiple of layers, and you roll the whole thing up.

Q. Doctor, referring to page 4 of the article, would you

note at the bottom of that page the list of uses or applications which are indicated, and I would ask you if that looks familiar to you?

A. Yes, it looks familiar to me. A number of them were in the suggested applications as published by Adams in his material with respect to the cells in the experiment.

Q. You are referring to the disclosure letters to Mr. Kettering and Captain Shumaker?

A. Yes, sir.

Q. Thank you, Doctor.

Would you comment just briefly on page 2 of the article?

A. Page 2 is entitled "Burgess AM Power Units Offer a New Type of Highly Portable Power Supply," and reference is made to constant voltage, high current and power output, constant output, light weight, long shelf life, types available, method of use and wide temperature [fol. 384] range, with the statement that the temperature is from —60° Fahrenheit, to as high as 150° Fahrenheit.

Q. Doctor, do these statements of characteristics, the temperature ranges, for example, sound familiar to you?

A. Yes, they sound almost like Adams' credo.

Q. Do you agree with the statement made in the title that these offer a new type of highly portable power supply?

A. They do.

Q. Thank you, Doctor.

Doctor, I would now like to refer you to Commissioner's Exhibit No. 2, which are the Proceedings of Tenth Annual Battery Research and Development Conference, Power Sources Division, Signal Corps Engineering Laboratories, Fort Monmouth, New Jersey. The first one I would ask you to refer to is the earliest one in the Proceedings of the Tenth Annual Battery Research and Development Conference, and therein will you please refer to the article on Water-Activated Batteries, by Mr. Morse of the Eagle-Picher Company, and let me have any comments you wish to make on this article?

A. This is on page 23, and the article starts out:

> "The water activated battery systems are among the relatively new power sources which have become extremely important to the Military during the past

decade. Their inherent characteristics are such [fol. 385] that their use will expand as the Armed Forces continue to utilize more and more equipment to increase the efficiency of the soldier."

The statement is made that batteries of this type are small and light in weight, and the power output is high compared with other common batteries, and they operate with good efficiency over a wide temperature range.

It further states:

"They are manufactured as dry primary units and as such are capable of indefinite maintenance-free storage without deterioration. Ordinary tap water or salt water serves as the electrolyte. The definite trend to water activated batteries for high altitude and sea water applications indicates they are unsurpassed as one-shot power packs for low temperature use and for underwater operation."

Q. Doctor, based on your experience in the battery field, do you agree with the statements of fact and conclusions arrived at in that paragraph?

A. I do, and I say that because they have been confirmed by so many others.

Q. Continue.

A. He says:

[fol. 386] "The most widely used water activated systems are silver chloride/magnesium and cuprous chloride/magnesium."

He says:

"Ten years ago only the silver chloride system was being considered for water activated battery applications. Development programs under the sponsorship of the Signal Corps brought out the feasibility and the economic advantages of the cuprous chloride system."

Q. Doctor, will you summarize this in your own words?

A. The reference is then made to supplying of radiosonde equipment and pilot balloon lighting units with batteries of this type.

Later on it states about the intense interest aroused by the cuprous chloride system as a practical and economical power source.

Q. Do you agree, Doctor, that the cuprous chloride system has become a practical and economical power source?

A. Yes, sir.

There is a reference to the many advantages of this type of battery in underwater service, and then some of the designs resulting in potentials of up to 1,000 volts and operating life of about 70 hours.

Then there is a reference to the "in-air" discharge [fol. 387] with the silver chloride radiosonde battery, and that in this unit in its specific form Burgess replaced a lead acid battery and the BA-259 was developed on the basis of a low cost unit as a direct replacement.

Q. For which battery, Doctor?

A. For the silver chloride-magnesium battery.

Q. What was the chronological series of batteries shown here?

A. First a silver chloride replaced the lead acid battery, and then the cuprous chloride system replaced the silver chloride.

Q. Thank you.

A. Then they talk about performances and say what the comparison of the silver chloride-magnesium unit and the cuprous chloride-magnesium unit is, stating:

> "The silver chloride unit reached operating voltage more quickly, but otherwise the electrical performances were similar."

The article is illustrated with photographs of types, and on page 25 there is a statement:

> "The program which led to the successful design of these batteries included countless electrical performance tests with the active components and extensive mechanical development with circuitry and [fol. 388] containers."

Q. Doctor, let me ask you a question on that. Is there in normal development a necessary test program and a design program to obtain the components, where a device is designed for commercial or practical use?

A. Almost invariably there will be design and engineering from a concept of a system for the additional development of the system.

Q. Is it customary to find in one specific development operation both a novel concept and its form for commercial use simultaneously?

A. That occurs very seldom.

Q. Thank you, Doctor.

A. The statement on page 25 says:

> "Almost all the batteries shown in the slides have been constructed using the cuprous chloride/magnesium system. There is no doubt that each of the units could have been built with silver chloride elements, but economic considerations prevented their use."

Then it goes on to state:

> "The Radiosonde battery program was an example of this situation. It is estimated that at least five million dollars has been saved by developing [fol. 389] the cuprous chloride BA-259 battery."

That was the battery referred to earlier, first in the magnesium-silver chloride form, which replaced the lead storage battery, and then in turn was replaced by the cuprous chloride-magnesium battery.

Q. Doctor, would you note for the record what is the designation of the battery in Trial Exhibit No. 7?

A. It is BA-259 and the cell is marked "AM—Eagle-Picher Company."

Q. Then the statement in this article relates to the development of this cuprous chloride battery?

A. Yes, sir.

Q. On this one specific model five million dollars was saved, according to the import of the article. Is that correct?

A. That would be the import of this article.

Q. Will you continue, Doctor?

A. They continue the article with this statement:

"With larger units, the proportion of silver to the other basic costs is increased and the proportional increase in cost per battery is magnified."

In the next paragraph there is a statement as follows:

[fol. 390] "The development of widespread use of water activated battery systems, and especially the cuprous chloride/magnesium system has helped immensely in rounding out the sources of battery furnished power."

There is a concluding statement as follows:

"There can be no doubt that the addition of water activated batteries to the family of power sources has brought about developments which would otherwise have been technically or economically impractical."

The concluding line is that the field of application is broadening.

Q. Doctor, does that statement concur with the statement which we have seen in prior references, that this represents a new source of power?

A. Yes, sir.

Q. Doctor, will you refer briefly to the Proceedings of the Eleventh Annual Battery Research and Development Conference, in which there is an article on Water Activated Batteries by Mr. Morse of the Eagle-Picher Company, the same man who wrote the previous one, and comment on that?

A. On page 69 the first sentence refers to these batteries as "an accepted and important type of portable power supply."

[fol. 391] He is referring to the two water-activated systems most widely used, the silver chloride-magnesium and the cuprous chloride-magnesium. There is a statement that the cuprous chloride battery was developed in the period from 1946 to 1950 under the direction of the

Signal Corps Engineering Laboratories, and that it was developed solely because of the economic advantage.

There is a discussion on the next page of the technique for making cuprous chloride electrodes. In this technique we find a milling operation, involving a mixing, and it states:

> "The result is to produce a mixing and calendering effect on the material being milled."

That would be the mixing operation.

Then in the next sentence there is this statement:

> "The availability of the heat which is applied by the addition of steam internally to the rolls makes it possible to use low melting plastic material with little or no solvent content."

They are referring to a vinyl chloride compound, and it states that the selection of the plastic carrier material was arbitrary. Now you have a liquefaction and there is a statement in the next column which states:

> "The rolls are four inches in diameter and are [fol. 392] heated internally by means of low pressure steam. For the production of sheet material the dry mix is added to the rolls in powder form and the heated rolls melt and mix the plastic and flow the material into a sheet."

After the material is heated, you have solidification. So that this technique is described as mixing, blending and liquefaction, shaping, forming and solidification.

Q. Doctor, this is a cuprous chloride machine mixture, is that correct?

A. Yes, sir.

Q. Is there anything else of interest here?

A. On page 71 there is a statement that water activated batteries are quite uniform with reference to their performance at low ambient temperatures, and that they are quite well known for this performance.

Q. Thank you, Doctor.

Doctor, will you refer briefly to the next Battery Con-

ference, the Twelfth Annual one that we have here, held in 1958, in which there is an article by Mr. Broglio of the Eagle-Picher Company on water activated batteries, on page 88?

A. In the introduction there is a statement:

> "The common water activated batteries which we have discussed from year to year continue to find [fol. 393] a constant expansion in their field of application."

He was there referring to water-activated batteries and that is specifically in the field of meteorology.

Then again there is a reference to the BA-259, where it states:

> "The BA 259 unit, of which nearly a million have been built, is the standard example of the successful application of a cuprous chloride battery. This battery has been supplying much of the power to gather weather information from radiosonde balloons."

And there is a statement as follows:

> "The most significant point about these batteries is that they operate under environmental conditions which would normally freeze the electrolyte and cause them to be inoperative."

Q. Doctor, were you a flier in World War I?

A. Yes, sir.

Q. Doctor, was weather information important to your ability to come back from missions?

A. It was extremely important, and we had very little weather information, only what we could observe ourselves.

Q. Did they have radios in World War I?

A. Radios of a sort, which gave us very little [fol. 394] performance.

Q. Did they have balloons in World War I?

A. Yes.

Q. Thank you, Doctor.

A. In the discussion there is a statement:

> "Everyone knows and understands that these side reactions allow these batteries to operate at —65° F.; however, the same heat which causes them to operate in cold temperatures, tends to cause the reactions to fail when normal or high temperatures are involved. Simply because the BA-259 is successful does not mean that any battery requirement can be filled by a water activated unit."

What he is saying is that the systems are so combined and designed to suit a set of expanded operating conditions, and you cannot take one design and apply it uniformly, any more than you could take an automobile motor and put it in a tank or truck or a racing car and expect to have the same performance each time.

He emphasizes this by saying:

> "The fact that the battery electrolyte is capable of ionic conduction in a narrow temperature band precludes the indiscriminate application of these units. The BA-259 is successful because of a particular [fol. 395] combination of conditions. The load on the BA-259 is high enough to cause the unit to generate sufficient heat to operate at —65°."

This again sounds a little like Adams.

Q. Would you read the next sentence about the load, Doctor?

> A. (Reading) "The load is low enough in comparison to the physical size of the battery that it will not boil the electrolyte dry too quickly when the unit is operated at normal temperatures."

Q. Doctor, may I ask you if your understanding of that sentence is that this battery can boil?

A. Yes, this battery can boil.

Q. Do you mean the BA-259, this successful battery of which the Army has purchased over one million, can boil?

A. It can, if incorrectly applied.

Q. Depending on the load and the temperature conditions to which it is subjected?

A. Yes, sir. In other words, it was designed to meet a specific set of conditions.

Q. And it was designed to meet a specific load in addition to a specific temperature?

A. Yes, sir.

Q. If you change the load and change the temperature, [fol. 396] the battery might boil over quite readily?

A. It might.

Q. Thank you, Doctor.

A. There is a statement on page 90 about the tools available to the battery designor, with the indication that if the battery runs too hot, you can take acid and reduce the battery activity and help prevent it boiling dry. Glycerine can be added to keep the battery operating at higher temperatures, but the simplest expedient to spread the operating temperature range is to increase the size of the battery.

Q. Doctor, I want to ask a question on the first sentence you referred to, which says:

> "There are tools available to the designor which can help alleviate the high temperature difficulties but little to help low temperature operation."

What does that mean concerning high temperature difficulties which one might experience with this type of battery?

A. If you don't have the proper design, this type of battery might function as what is referred to as a runaway system. You correct that in your design by making it a larger battery with reference to the load. For low [fol. 397] temperature operation in batteries, it has always been a problem, and the storage batter of the lead-sulphuric oxide type, nickel-cadmium type, sometimes referred to as the Edison type, always have had low temperature operation difficulties. It says that you can correct the load on the Edison type by adding lithium hydroxide to the caustic, but you still can't get down low enough, and when you get down to low temperature the power output disappears and it ceases to be an effective mechanism.

Commissioner Lane: We will take a short recess.

(Short recess.)

Commissioner Lane: You may continue, Mr. Reilly.

By Mr. Reilly:

Q. Doctor Mantell, do you understand the chemical reactions or other reactions which take place in the magnesium-cuprous chloride or the silver chloride-water activated system?

A. No, I do not. I find myself in agreement so far as their chemistry and electrochemistry is concerned, that they are not as simple as some electrochemical reactions. That is confirmed by what others say about the system.

Q. You say "others." What specific references do you have in mind?

A. I am specifically thinking of Chubb in Patent No. 2,745,893 with respect to cuprous chloride-magnesium batteries.

[fol. 398] Q. Is there another one?

A. And Chubb Patent No. 2,817,697, which is a cuprous chloride-magnesium battery.

Mr. Reilly: You will recall, Mr. Arseneau, that in my letter I gave you notice that these patents would be discussed by the Plaintiffs.

By Mr. Reilly:

Q. What are your observations concerning these references, Doctor?

A. I find, referring to Patent No. 2,817,697, line 62, the first column, that it reads:

> "The exact nature of the complex chemical current-producing reactions of this type of cell is not known in any substantial detail and much of the development has necessarily depended upon the employment of purely empirical methods."

That is in a patent where it concerns cuprous chloride-magnesium batteries.

There is a further statement as follows:

> "No detailed theory can be offered as to why small quantities of cadmium chloride in the electrolyte tend to reduce overheating. . . ."

Q. Are you referring there to lines 64 to 69 in column 2?

A. Yes, sir, and the next page.

[fol. 399] In patent No. 2,745,893, I find myself in agreement with the statement on the bottom of column 1, line 67, which reads:

> "From the point of view of theory, cuprous chloride is relatively insoluble in water, whereas cupric chloride is relatively soluble. In the presence of water, cuprous chloride tends to convert to cupric chloride and copper or to complex copper salts and hydrates. Since the cell of the type in question produces a current which is relatively large in relation to the weight of the materials which constitute the electrodes, it must be assumed that the cuprous chloride of the positive electrode is dissolved in the electrolyte to a degree substantially greater than it would be if it remained as cuprous chloride. The cuprous chloride magnesium cells which utilize porous or pasted positive electrodes generate substantial heat in operation, and this heat accelerates the conversion and disintegration of the positive electrode."

Then he goes on and says in column 2, line 15:

> "In practice, however, the reactions do not correspond to any simple theory and copper compounds are deposited in the bibulous pad between the positive [fol. 400] and negative electrodes."

He goes on in effect and says:

> "We don't have an adequate theory and we do not have any positive evidence which would say: 'All right, all you have got to do is to put them together and you will know what will happen.'"

This is not only true in this system, Your Honor, but Vosburgh and his students at Duke University have been working for a couple of decades to determine what happens to manganese dioxide in the old dry cell system to determine exactly what compounds are formed, and they have used every available scientific methods, X-ray analysis, infraction and the like, and petrographic analysis to determine this.

Q. Doctor, do I understand that you have said there is no theory today that will explain the operation or the characteristics of this battery?

A. That is correct.

Q. Is there any theory from which you can predict the effect of additions of substances to the electrodes or the electrolytes?

A. To a small degree, yes, but to a greater degree, no.

Q. Doctor, was there any theory available in the art prior to 1940 from which one could have predicted the operation of this battery?

[fol. 401] A. I would say in 1940 it was ridiculous to take an insoluble magnesium material and insoluble cuprous chloride and combine the two with an insulator like water.

OFFERS IN EVIDENCE

Mr. Reilly: I neglected to offer as exhibits the two patents that the Doctor referred to, and I would like to have them identified and accepted in evidence as Plaintiffs' Exhibits Nos. 40 and 41.

Commissioner Lane: Which is which?

Mr. Reilly: The one concerning which he testified first, which I believe was the latest one, would be No. 40, and the earlier would be No. 41.

Commissioner Lane: Any objection, Mr. Arseneau?

Mr. Arseneau: No, Your Honor, I have no objection.

Commissioner Lane: There will be received in evidence Plaintiffs' Exhibits Nos. 40 and 41.

(Patent No. 2,817,697 to M. F. Chubb dated December 24, 1957 was received in evidence as Plaintiffs' Exhibit No. 40.)

(Patent No. 2,745,893, to M. F. Chubb, dated May 15, 1956, was received in evidence as Plaintiffs' Exhibit No. 41.)

Mr. Reilly: Before cross begins, may I confer with my associate counsel here?

Commissioner Lane: Yes, sir.

(Discussion off the record.)

[fol. 402] Commissioner Lane: You may proceed.

Mr. Reilly: Your Honor, I might just ask one question further of Mr. Arseneau.

Commissioner Lane: Yes, sir.

Mr. Reilly: Is there any more information, documents, et cetera, that the Government wishes to give to the Plaintiffs at this time?

Mr. Arseneau: I am in the position in responding to that question, that I can state that we have turned over to you everything that we have received up to now.

Mr. Reilly: Thank you very much. Your witness.

Commissioner Lane: Are you ready to proceed, Mr. Arseneau, with your cross-examination?

Mr. Arseneau: Yes, Your Honor, I am.

Commissioner Lane: Very well. You may remain seated, if it is more convenient.

Mr. Arseneau: Thank you very much.

Cross-examination.

By Mr. Arseneau:

Q. Doctor Mantell, I would like to ask you whether you recall during your direct examination using the term "melting cuprous chloride with heat"?

A. Yes.

Q. Do you recall using the term "melting cuprous [fol. 403] chloride with water"?

A. Yes.

Q. Do you recall using terminology to the effect of "liquefying cuprous chloride with water"?

A. Yes, sir.

Q. I will also ask you, Doctor, if I may, do you recall saying that six parts of cuprous chloride dissolved in 100,000 parts of water means that it is practically insoluble?

A. In the ordinary sense, it is insoluble.

Q. I would like to ask you this question: Would you regard a paste or slurry comprised of discrete undissolved particles with water between the particles as an example of particles in a melted condition?

A. Yes, I regard that as an example of particles in a liquefied condition.

Q. Let me rephrase the question. If a group of cuprous chloride particles are in a slurry or paste or the like, and let us say water is added, do you regard the cuprous chloride particles themselves as having been liquefied?

A. I regard it as the other step to a liquefaction step.

Q. That is a good answer.

Mr. Reilly: Is there any evidence in the record for the assumption that counsel is making concerning the [fol. 404] existence of discrete particles? I cannot recall anything in the record thus far.

Mr. Arseneau: My answer to that is that this relates to the definition of the word "fused" from the Adams patent.

Further than that, the melting or blending or mixing and incorporating and unifying with heat is in a broad area. Then referring to fusing, melting with water or liquefying the CuCl has been mentioned and it is something that Defendant's counsel should have an opportunity to go into on cross-examination.

Mr. Reilly: I am not objecting.

Mr. Arseneau: There was testimony that cuprous chloride was insoluble.

Mr. Reilly: I am not objecting to your going into it. You do not have to defend your right to cross-examine, but I was merely pointing out that you were making assumptions in your question that are not in the record. I was pointing out that there was nothing here so far with respect to that.

Mr. Arseneau: I will repeat the question, and please wait before answering.

By Mr. Arseneau:

Q. My question is whether you would regard a paste or slurry comprised of undissolved cuprous chloride particles with water as an example of such particles in the [fol. 405] melted state or the liquefied state?

Mr. Reilly: I will object to the form of the question. I think it should be broken down into separate questions. I do not want to object all the time, and I think I will let you go ahead.

Commissioner Lane: I think Doctor Mantell understands. You may proceed.

The Witness: If I assume that the cuprous chloride in water remains as a discrete particle—with which I do not agree—cuprous chloride also reacts with water, and in reacting in my mind, regardless of whether it is a discrete particle or not in the water, the dispersion of the paste would be a liquefaction.

By Mr. Arseneau:

Q. Would you regard the cuprous chloride compound itself as liquefied?

A. The cuprous chloride is made into a form which is liquid by the use of the water, so that for purposes of the structure, it is liquefied.

Q. I would like to ask what kind of reaction takes place, and whether this is still cuprous chloride after this reaction occurs?

A. I do not know. The reactions are quite complex, hydrates of the normal form of water crystallites, being [fol. 406] hydroxide compounds and copper compounds in form. There is evidence that if you leave cuprous chloride exposed to the air, it even changes its color, and that there is quite a range of color, and you get a green color and it does react to water in such a way that we may say it is insoluble in the ordinary method of describing insolubility.

Q. Let us get to a different angle. You say that you recall using the term "melting cuprous chloride with water," and you also used the term "liquefying cuprous chloride with water."

I would like to ask you if you recall a statement as to what the melting point of cuprous chloride is?

A. Yes, 422 degrees Centigrade.

Q. Can you tell us what this temperature value means in so far as the salt, cuprous chloride, is concerned?

A. I do not quite understand.

Q. I asked you a question and you gave the figure of 422 degrees Centigrade, didn't you?

A. Yes, sir.

Q. I ask you what this temperature value means to you?

A. It means that the temperature at which cuprous chloride melts is considerably higher than room temperature.

Q. Let me ask you this, Doctor: If you have cuprous chloride and ambient water around it at less than 422 [fol. 407] degrees Centigrade, do you regard the cuprous chloride in this mixture as being melted?

A. It is melted in the sense that I used the word "liquefied."

Q. Is it melted in the same sense as would be intended if a person raised the temperature to 422 degrees Centigrade?

A. Yes, you could say that.

Q. You say that with CuCl and ambient water around it at less than 422 degrees Centigrade—you say that the CuCl is in liquid form at that stage?

A. It is liquefied, and the two methods are equivalent, and the whole object of the thing is to get it into a stage where you can pour it.

Q. You said "liquefied." Do you mean the composite of the fluid and the particles or do you mean the particles of CuCl themselves?

A. I refer to the composite.

Q. Thank you very much. Another question I would like to ask you, sir, if I may is this:

If you place cuprous chloride in a solution of some organic solvent, which is below 422 degrees Centigrade, and which does not react with the cuprous chloride, do you regard the particles of cuprous chloride as melted or liquefied in that mix?

[fol. 408] A. I regard the entire operation as a liquefaction.

Q. Are you referring to the composite of the particles or the binder?

A. To all intents and purposes, cuprous chloride has been put in, and it is in a form where it has been liquefied and that is susceptible to further use in developing a unified structure.

Q. If the CuCl had not been raised to 422, there is still the possibility that liquefaction has taken place?

A. Yes, sir.

Q. Of the CuCl particles themselves?

A. The result of this operation is to give you a liquefaction of the cuprous chloride, so that it is now pourable.

Q. When you refer to liquefaction, are you referring to the composite or are you referring to the CuCl particles themselves?

A. I am referring to the results of the operation.

Q. I think I am clear on that, Doctor.

Doctor, I would now like to place in your hands from the welter of exhibits that we have here, Defendant's Exhibit No. 1 for identification, which I believe is the Niaudet article.

A. Yes, sir.

[fol. 409] Mr. Arseneau: Does the Court have a copy of this?

Commissioner Lane: No, sir, I have not.

Mr. Arseneau: Doctor Mantell, you can use this copy.

The Witness: I was trying to find a copy.

Mr. Arseneau: I can give you the Court's copy to use.

(Handing Court copy of Defendant's Exhibit No. 1 to witness)

Commissioner Lane: Doctor Mantell is trying to find a copy.

Mr. Arseneau: My only hesitation is that mine is annotated.

Your Honor, would it be advisable to have the Court look at the copy that the witness has, and we can use the copy I have here?

Commissioner Lane: All right.

The Witness: Let me see if I have a copy, Mr. Arseneau.

Mr. Arseneau: All right.

The Witness: (Examining papers) I have found a copy, Mr. Arseneau.

By Mr. Arseneau:

Q. All right. Doctor Mantell, do you have before you the Niaudet article identified as Defendant's Exhibit No. 1?

A. My copy may not be as complete as yours.

Q. I think these are photostats of selected pages. Will you please turn to page 201 of that article, and beneath [fol. 410] the caption entitled "Chloride-Of-Silver Battery," I wonder if you would inspect the second paragraph in addition, not the paragraph starting "Marie Davy," but the one just below?

A. Yes, sir.

Q. Will you tell us in what form the silver chloride is referred to in this passage?

A. He refers to "chloride of silver melted in a silver crucible . . ."

Q. I understand. Thank you very much.

Will you turn to page 202 and to the top paragraph of the Niaudet article?

A. Yes, sir.

Q. I believe, subject to correction, that this refers to Warren De La Rue, and that he is mentioned at the bottom of the last paragraph on the previous page?

A. Yes, sir.

Q. Can you tell us what is stated on the top of page 202 as regards the form of the silver chloride?

A. This statement is made:

> "In the beginning of his researches, this physcist used chloride of silver in the shape of a powder or paste, and his liquid was a thin solution of sea-salt."

Q. Thank you very much.

[fol. 411] Doctor, I would like to ask you this question: Do you characterize the type of silver chloride referred to on page 201 by Davy and the paste form referred to on the top of page 202—do you characterize both of these as being fused silver chloride?

A. I characterize them both as being the terminology of

Adams in reference to his use of the word "fused," in that the final product, the final unified product, is the result of obtaining liquefaction and solidification.

Q. Is it correct to state, then, sir, that you do regard both of these described methods as amounting to a fused silver chloride?

A. I describe them as embodying the operations equivalent to the term used by Adams, in other words, "fused."

Q. Doctor, I would now like to hand you what has been referred to as Plaintiffs' Exhibit No. 39, which I think is an excerpt from the Journal of the American Chemical Society, is it?

A. Yes, sir.

Q. The article by Mullen and Howard, and I would like to refer to the last paragraph on page 529, and more particularly to the reference to a pasted type cell, and ask you if you would read that passage?

A. (Reading) "This cell was of the pasted silver [fol. 412] chloride-zinc type made similar to the Leclanche dry cell."

Q. Do you regard the appearance of the word "pasted" in the Plaintiffs' exhibit as describing an electrode made by fusion?

A. Made by fusion in the same terminology as employed by Adams.

Q. Doctor, I am going to place before you a copy of the Adams patent, which I believe has been identified as Trial Exhibit No. 10, and I would like to direct your attention, if I may, to page 1, the right-hand column, and more particularly line 6, and actually the paragraph starting on line 6, and can you tell us from your reading of that paragraph what technique Mr. Adams disclosed for making his fused cuprous chloride electrode?

A. He uses a technique which he describes as involving a mixing, a liquefaction by heating, a forming and a solidification.

Q. Is it fair to say that Adams does clearly teach the step that you treat the cuprous chloride by means of an elevated temperature and raise it to a molten condition and pour it into a mold?

A. That is one example.

Q. Another question I would like to put to you, sir, [fol. 413] is this:

First of all I would like to direct your attention to page 2 of the patent and I would like to direct your attention to the omnibus clause directly above the claims. I think it is lines 18 through 21, is it not?

A. Yes, sir.

Q. I would like you to tell me, if you will, sir, where else in the Adams patent—not referring to the omnibus clause—can you show me by citing the column and lines in the Adams patent, where the word "fusing" is given any other interpretation than raising it to a certain condition and pouring it into a mold?

A. In the material in the Patent Office it was pointed out that Adams actually made a definite distinction between "fused" and "melted," in that he changed one of them but he did not change the use of the other word, and in so doing he made a clear distinction that his use of the word "fused" embraced far more than "melted."

Mr. Arseneau: I am not going to object to that answer remaining on the record, but I do not think it is responsive.

Mr. Reilly: I do not think you should, because he answered the question.

Mr. Arseneau: I asked whether there was anywhere other than in the omnibus clause any place where a tech- [fol. 414] nique other than heating and cooling in a mold is shown?

Mr. Reilly: I object to the remarks by Mr. Arseneau.

Commissioner Lane: Objection overruled. You may continue.

By Mr. Arseneau:

Q. Doctor, I may have misled you. Let me restate the question.

My question is this: Other than the omnibus clause in Adams, ahead of the claims, can you show us any other occurrence, or can you give us the column and line of any other passage in Adams, which defined "fusion" as

other than actually raising to a molten condition and pouring into a mold.

Mr. Reilly: I object to that question as leading, Your Honor, and there is no evidence here that there is a specific example which refers to "fusion" only in the melting.

Mr. Arseneau: Your Honor, may I state that the substance of the objection was with regard to leading, and this is cross-examination.

Commissioner Lane: I think the question is all right. It is directed to the patent specification.

Mr. Arseneau: That is true.

The Witness: I find the word "fused" in line 7, in contradistinction to that language, which reads that the cuprous chloride may be poured, and one is broader than the [fol. 415] other, and it justifies my definition of the use of the word. That is backed up by what happened in the action before the Patent Office.

Mr. Reilly: I might offer to stipulate, if it would be helpful, that there is no other example which appears on the face of the Adams patent. There is no specific example shown other than there. That is clear from the patent.

Mr. Arseneau: I think entering that stipulation into the record might expedite matters a little bit. I will stipulate to that.

By Mr. Arseneau:

Q. Doctor Mantell, I would like to ask you, in your professional experience have you encountered the term "heat of fusion"?

A. Yes, sir, that is a common term.

Q. Can you tell us what the term means to you?

A. It eventually may mean, in a limited sense, heat of melting. It may also mean, in a restricted sense, heat of reaction, where you refer to other fusions, other than melting.

Q. As applied to a unit cube of cuprous chloride, can you tell us what the value per unit weight of cuprous chloride would mean to you?

A. I can't do it at the present time.

Q. I am asking you what would the value mean to you, the heat of fusion per unit weight of cuprous chloride?

[fol. 416] A. If I assume your terminology and your use of words, the value would mean to me that for a unit of specific weight so much thermal energy would have to be added to make it change from a solid to a liquid.

Q. Thank you. Do you remember testifying to fused as blended, incorporated or unified?

A. Yes, that is using the Adams terminology.

Q. In a mixture or batch, where cuprous chloride particles were blended, mixed and unified with water, can you tell us what the relevance of the term "heat of fusion" would be in that sort of mixture?

A. None at all.

Q. Thank you very much. Have you in your professional endeavors become familiar with Hackh's Chemical Dictionary?

A. Yes, sir.

Q. Will you tell us what weight or credibility you attach to this book, if any?

A. The credibility I attach to it is that which may be attached to any dictionary, but only when completely substantiated by a wide range of dictionaries. To use it as a reference alone, I certainly would not.

Mr. Reilly: I was going to suggest that if the witness is going to be questioned about something not in evidence, I would like to have the document identified before the [fol. 417] question is asked, and I would like to see a copy of it so that I can examine it.

Mr. Arseneau: My answer to that statement, first of all, is that I think it is proper cross-examination of the witness, and, secondly, we have no intention to cross-examine Doctor Mantell with respect to any papers which we do not formally identify and also give a copy to opposing counsel.

My preliminary question was not to test him as to its value but was whether the Doctor in his professional endeavors had become familiar with Hackh's Chemical Dictionary, and what weight he accords to it.

Mr. Reilly: There are a lot of editions, and I want to see what you are talking about.

Commissioner Lane: I think the witness answered by saying that he knows of the book, and that was the extent of the question.

Mr. Arseneau: I will hand the reporter photostatic sheets from the book entitled "Hackh's Chemical Dictionary," and will ask the reporter please to mark it as Defendant's Exhibit No. 2 for identification.

(Four photostatic sheets taken from Hackh's Chemical Dictionary, being cover page, 2nd page and page 403 and 442, were marked for identification as Defendant's Exhibit No. 2.)

Mr. Arseneau: I will give a copy to opposing counsel [fol. 418] and I will also place a copy of the material before the witness. I would like to direct the witness' attention to——

Mr. Reilly: Your Honor, may I have a chance to examine this article first?

Mr. Arseneau: Excuse me.

Mr. Reilly: I have previously supplied Mr. Arseneau with all the articles I relied on, and I would like to have a minute to look at this.

Mr. Arseneau: Certainly.

Mr. Reilly: I was reading page 403, and then went over to page 442. Where is page 404? That is interesting to me.

Mr. Arseneau: I think after I propound the question, we will be in better position to have the Commissioner rule as to whether it is missing or not.

Mr. Reilly: I think I am entitled to have the remainder of this before the witness answers. Where is the book?

Mr. Arseneau: We will be glad to produce the book after lunch, if it will be of assistance.

Mr. Reilly: Can you go to another topic now?

Commissioner Lane: Let us hear the question first.

By Mr. Arseneau:

Q. The question that I was about to propound is this: Directing your attention to page 403, the right-hand column—do you have page 403 there?

[fol. 419] A. Yes, sir.

Q. Do you see there the first full paragraph down from the top a definition of the word "fused"?

A. I have the paragraph to which you are referring, which starts with "fused," yes.

Q. That is right, sir?

A. Yes, sir.

Q. Would you tell us what that definition means to you, sir?

A. I will read the definition and then interpret it as it is stated.

Q. Thank you.

A. (Reading) "Cooled to a compact mass after having been molten or sintered, as fused ash, slag or sodium hydroxide."

When it says "having been molten or sintered," that does not mean that it has been molten.

Q. I understand, Thank you.

Would it be fair to state, at least in so far as you understand this definition that "fused" has the meaning of "cooled to a compact mass after having been molten"?

A. Yes, but it also includes the word "sintered."

Q. That is true.

A. Which does not include having been molten.

[fol. 420] Q. What does "sintered" mean to you?

A. It means compaction by a wide range of processes, and it might involve heat at temperatures considerably below the melting point, and it may involve low temperatures or it may involve pressure alone.

Q. I think I am clear on that, Doctor.

I would like to ask you this question: In view of the fact of the phenomena described in Adams or the technology described relating to chemistry and chemical reactions do you think it would be fair to resort to a so-called chemical definition?

A. Not at all. It is a fundamental rule that every patentee is his own lexicographer.

Q. I understand that, although I had forgotten it, and thanks for the reminder. The statement is that "every patentee is his own lexicographer."

Where the patent relates to a field involving chemistry and chemical reactions, do you not think it would be fair

to look in a definition of the chemical terms to find that out?

A. To look at this without consulting many others, no.

Mr. Arseneau: Your Honor, for whatever it is worth, I don't have any other questions on this exhibit at the present time, and I think the book can be brought over and [fol. 421] given to Mr. Reilly for inspection.

Mr. Reilly: I would like to have it because I would like to look at it. Let us have this marked for identification.

Commissioner Lane: It is already marked for identification as Defendant's Exhibit No. 2, and after Plaintiff sees the rest of this definition on "fusion," we can decide whether or not to add another page to this exhibit.

Mr. Arseneau: I understand.

By Mr. Arseneau:

Q. Doctor Mantell, you mentioned before that the patentee or the applicant does have a right to be his own lexicographer. Can you tell us where an attempt has been made to spell out what "fused" means?

A. He has spelled it out by not using the word "fused" in the sense that you are attempting to use it. He makes a distinction between "melted," "poured," and "fused," and goes to considerable trouble to do so.

Q. I am not sure that your answer is entirely responsive to the question. What I said is, since the patentee is his own lexicographer, can you show us in the text of the Adams specification what meaning was intended by Adams to be given to the word "fused"?

A. I would point that out with reference to the changes made in the prosecution.

[fol. 422] Q. The answer which you have just given is keyed to your testimony on the file history, but I will drop it for just now.

Doctor, directing your attention to the next point, during your direct testimony there was a question asked as to water or distilled water used in the Adams type cell, and I believe you testified that pure H_2O, immediately after filling the cells, was extremely non-conductive and practically an insulator. Do you recall that?

A. Yes, sir.

Q. Can you tell me this: Adams mentions the use of magnesium chloride. Can you tell me what the action of magnesium chloride is on the distilled water or the tap water which is used?

A. It would increase the conductivity and decrease the resistance.

Q. Can you tell me what the action of the magnesium sulphate is on the water?

A. It would have two effects: It would increase the conductivity of the water and decrease its resistance, but would also tend to keep the electrodes clean.

Q. I think I am clear on that, Doctor.

Do you recall testifying that when a cuprous chloride slurry dries out—actually I think we are talking about a [fol. 423] water slurry, that there were no changes in the chemical properties of the cuprous chloride. Is that correct?

A. Substantially.

Q. I believe you testified that when CuCl, cuprous chloride, was heated and cooled, and there was no change in the chemical properties of the cuprous chloride.

A. Substantially none.

Q. I notice that during the direct examination that both of your responses were keyed to the chemical properties of the resulting structure. Do you feel that the physical properties of the resulting structure would be the same in both cases?

A. I do not quite understand the question.

Q. Let me get at it a little bit differently. Do you feel if on the one hand cuprous chloride was added and poured into a mold, and on the other hand a slurry is made, and let us say that the water was allowed to dry out, you say the chemical properties would be the same, but do you think the physical properties in both samples would be the same?

A. What do you mean by "physical properties"?

Q. Maybe I am being a little ambiguous and I can be a little more precise. Do you think the degree of compaction or the density of each sample would be the same?

A. It might or might not be.

[fol. 424] Q. I would like to ask you this question:

Where a toluene binder is used to make a paste, do you recall testifying that it would evaporate off?

A. Yes, but it would not be a toluene vehicle alone.

Q. I understand. Tell me this: What happens in this body of cuprous chloride to the zones where the toluene had formerly been?

A. That might leave space behind, and it might not. I do not see how it affects the basic electrochemical system which we are talking about. We are not talking about minutiae.

Q. Can you tell us where slurries were made with particles of water, what happens to the zones or the areas between the particles when the H_2O is evaporated and driven off?

A. It depends on the manner in which it is dried. If you dry rapidly, you get a porous structure, and if you dry so that your drying rate is by diffusion, as in brick manufacturing, ou will get very much less porous structure.

Q. Is your statement that with a rapid rate there would be a porous structure obtained?

A. I would expect so.

Q. Thank you. I believe we have Trial Exhibits Nos. 7, 8 and 9 here, if I am not mistaken, which are samples, and I will place them before you, Doctor.

This first one is Trial Exhibit No. 7, which seems [fol. 425] to be the Eagle-Picher sample, and Trial Exhibit No. 8 is No. 292, about the size of a cigarette lighter, and this last one is Trial Exhibit No. 9, and if I may I would like to call your attention to the Adams patent, which is Trial Exhibit No. 10.

A. Yes, sir.

Q. I would like to refer you to lines 6 through 20.

A. Yes, sir.

Q. Excuse me, I mean the right-hand column, where he refers to the method of making the body 36. In connection with the precise method taught in that paragraph of raising cuprous chloride to a molten condition and pouring it into a mold, would you state to the Court or tell the Court

which, if any, of these Trial exhibits have a cuprous chloride electrode made in that fashion?

Mr. Reilly: What did you say about the cuprous chloride?

Mr. Arseneau: In a molten state and poured into a mold.

Mr. Reilly: In a molten state and poured into a mold and a piece of carbon placed in there on top.

By Mr. Arseneau:

Q. As between these three trial exhibits put in as the accused devices, I am asking which of any of them have a cuprous chloride construction formed by heating and then pouring it into a mold?

A. In terms of the exact and specific method of heating [fol. 426] the cuprous chloride and pouring it into a mold, none of these employ that precise method. They employ the equivalent thereof.

Q. Doctor, before I ask the next question, I have to ask Mr. Reilly a question.

A. All right.

Mr. Arseneau: Use was made of a book by Vinal yesterday, and I do not have any record as to whether it was ever marked for identification or received. Can you tell me whether it has been assigned a number?

Mr. Reilly: I must have missed it, if it was not given a number. Let me fulfill my obligation and identify it as Plaintiffs' Exhibit No. 42, and I will identify as the exhibit the first page of the book, Mr. Arseneau, and I regret that an error was made in photostating the second page because it was intended to show the date.

Mr. Arseneau: This is properly identified, and I think what we have got to concern ourselves with now is whether a number was assigned to it. I think I said there was no objection, but I am vague about it.

Offer in Evidence

Mr. Reilly: It is pages 1, 2 and 3, plus the cover page and the one page of preface, and let us identify and offer it now as Plaintiffs' Exhibit No. 42.

Mr. Arseneau: Does the Court have a copy of Plaintiffs' [fol. 427] Exhibit No. 42?

Commissioner Lane: Yes, sir, and it may be received.

(Pages 1, 2 and 3, together with cover page and preface page of an article entitled "Primary Batteries," by George Wood Vinal, received in evidence as Plaintiffs' Exhibit No. 42.)

By Mr. Arseneau:

Q. There was some testimony relating to Mr. Volta and with reference to the description of drawings of the Volta type of battery, and I would like to refer you to page 1, if I may, and also to page 2, just beneath the illustration.

Do you see where it says:

"Volta built his pile of silver, brass or copper," and so forth?

A. Yes.

Q. I would like to ask you if it is correct that during your direct examination you referred to the teaching of the pile type battery or a pile type cell by Volta?

A. I believe so.

Q. What do you mean by "a pile type cell," sir?

A. A pile type cell would refer to an assembly of individual cells in combination, so that they were adjacent to each other and perhaps electrically inter-connected.

Q. Could it be said that it was in inter-leafed [fol. 428] configuration?

A. Yes, sir.

Q. I wonder, in the light of your testimony just now on Volta, will you tell us whether it would be proper to refer to Trial Exhibit No. 7, which is the Eagle-Picher exhibit, No. 259, or to Trial Exhibits Nos. 8 and 9, or to the remnants thereof, as pile type cells?

A. They could be pile type or stacked type. It is known by a number of different names, but it is in contrast to an individual cell.

Q. I would like again to refer you to Trial Exhibit No. 10, Mr. Adams patent.

A. Yes, sir.

Q. I would like to ask you what the reference numeral in Figure 14 designates?

A. It designates the magnesium electrode.

Q. What configuration or what form does this magnesium electrode take, Doctor?

A. It is a cylinder.

Q. I understand. I would like to ask you, if I may, to tell the Court which, if any, of Trial Exhibits Nos. 7, 8 or 9, possesses an annular form or a cylinder.

A. Specifically?

Q. Yes, sir.

[fol. 429] A. None.

Q. In the Adams patent I would like to direct your attention to the reference numeral 26 and ask you if you will identify it for us?

A. This is the electrode of cuprous chloride, and it is also designated 36.

Q. Doctor, I would like to ask you with respect to those three trial exhibits on the table, which, if any of them, include a fused cuprous chloride element, positioned within an annular or circular electrode, comprised of magnesium?

A. None of them, but they are still equivalents.

Mr. Reilly: I will stipulate that none of those batteries to which Mr. Arseneau referred, neither Trial Exhibit No. 18 nor Trial Exhibits Nos. 7, 8 and 9, have cylindrical electrodes.

Mr. Arseneau: May we go off the record for just a second, please, Your Honor?

Commissioner Lane: Yes, sir.

(Discussion off the record.)

Commissioner Lane: Back on the record.

Mr. Arseneau: There is another stipulation concerning the use of a tubular cuprous chloride electrode.

Mr. Reilly: That is right.

[fol. 430] Mr. Arseneau: I believe the record shows by this colloquy that Doctor Mantell did testify that none of the Trial exhibits have tubular electrodes.

Mr. Reilly: I will stipulate that the electrodes in Trial

Exhibit No. 18 and Trial Exhibits Nos. 7, 8 and 9 do not have cylindrical tubular electrodes.

Mr. Arseneau: Is that the end of the stipulation? You are not taking any position as to whether those trial exhibits have a fused cuprous chloride stick or element down inside the magnesium?

Mr. Reilly: They do not have a cylindrical cuprous chloride electrode either.

I am not talking about claim language.

Mr. Arseneau: I am not talking about claim language, either, but I was talking about the structure of the accused system which was referred to.

Mr. Reilly: In all the batteries I have mentioned you have flat plate electrodes.

Commissioner Lane: Would you like to recess for lunch, Mr. Arseneau?

Mr. Arseneau: Very much so.

Commissioner Lane: We will recess now until 2:00 o'clock this afternoon.

(Whereupon, at 12:40 o'clock p.m., a recess was taken [fol. 431] until 2:00 o'clock p.m.)

AFTERNOON SESSION

Commissioner Lane: You may continue, Mr. Arseneau.

Mr. Arseneau: Thank you very much.

WHEREUPON CHARLES L. MANTELL, the witness on the stand at the taking of the recess, resumed the stand and testified further on behalf of the Plaintiffs, as follows:

Cross-examination (Resumed)

Mr. Arseneau: I might say, for the benefit of Mr. Reilly, that according to my best information prior to lunch, the matters we referred to should be here expeditiously.

Mr. Reilly: All right.

By Mr. Arseneau:

Q. Doctor Mantell, do you recall yesterday testifying that you first heard of making a cuprous chloride electrode —I won't say by "being fused," but it was made by melting, mixing and pouring it, and that it would be given a reasonable porosity by adding constituents thereto?

A. Yes, sir.

Q. I am going to refer to Trial Exhibit No. 10 again, which is the Adams patent. Will you do this first: Show [fol. 432] us where in the Adams patent there is any disclosure of either the purpose or the identity of materials or constituents which might be added to make this type of electrode porous?

A. He describes the addition of wood carbon and he states that that constitutes a catalytic agent "which renders the electronegative electrode 26 successful for the purpose intended, the exact chemical action being unkonwn to me."

Q. Will you straighten me out on this: Did the purpose for using a carbon as a catalyst consist of the catalytic action referred to, or the construction of the electrode, or was it in the latter case the battery as a whole?

A. It is both.

Q. I understand. Is it your position that the constituents in Adams would give porosity through the carbon which is added?

A. Yes, sir.

Q. Doctor, there is another point which occurs to me, which might be as tricky as something else I have heard here, but the point is this: If you take a salt and apply it equally to raise the molten condition, and if you remove the heat and allow it to cool back down, in what respect would something like carbon enhance or modify the change in any chemical reaction?

A. Very slightly.

[fol. 433] Q. Is it ordinarily proper to regard a catalyst as something which is used in connection with some sort of a chemical reaction?

A. That is one of the old definitions of a catalyst.

Q. Thank you.

Do we have Trial Exhibit No. 14? I believe it is a certified copy of Mr. Adams' file history.

Mr. Reilly: It is Trial Exhibit No. 11.

Mr. Arseneau: I should correct that. It is Trial Exhibit No. 11.

By Mr. Arseneau:

Q. Doctor Mantell, do you recall during your direct examination referring to Trial Exhibit No. 11 and particularly to the amendatory changes that were made in certain of the claims?

A. Yes, sir.

Q. If you will, I would like to have you turn to page 20 of Trial Exhibit No. 11. I think 20, by the way, is the chronological number used by the photostatic people in the Patent Office.

I think it will be "20" at the bottom of the page.

Commissioner Lane: It is the first page of "Amendment Under Rule 78."

Mr. Arseneau: I think it is marked with a "B."

[fol. 434] By Mr. Arseneau:

Q. Do you have that before you, sir?

A. Yes, sir.

Q. I wonder if you would turn to the passage there and I will give you a few minutes to glance over it.

A. All right.

Commissioner Lane: The remarks under Amendment?

Mr. Arseneau: Just begin with the "Remarks," and I would like to have the Doctor read those several lines down to the bottom of the page, if he will, and perhaps the top line of the next page.

The Witness: (Reading) Yes, sir.

By Mr. Arseneau:

Q. Doctor, I am precluded, just as I think Mr. Reilly was, from asking you any questions as to the impact of this in the prosecution, or what the impact might have been in connection with it, but having qualified as an

expert electrochemist, can you tell us in fact what the significance of this paragraph is?

A. "It is believed that the proposed changes to page 4 merely clarifies the operation without adding new matter."

Q. Will you go a step further, sir?

A. Are you referring to the next paragraph?

[fol. 435] Q. I did not mean to read it but I mean in so far as the paragraph on the bottom of page 20 is concerned, can you say a few more words about that as to what you think is intended here, or what you construe this to mean?

Mr. Reilly: I think there should be a specific question put to the witness.

Mr. Arseneau: All right.

By Mr. Arseneau:

Q. If the question is ambiguous, let me put it this way: Referring to this paragraph at the bottom of page 20, what does this tell you about Adams' method of manufacturing the body 36?

A. It tells you that cuprous chloride is placed in a crucible in the presence of carbon and heated to about 400° to 500° Centigrade, and then allowed to cool.

Q. I wonder if in the same Trial Exhibit No. 11 you would turn to page 7. I think there is a pencil "7" at the bottom of that page, of what looks like the first of the claim pages. Do you have that, sir?

A. (Reading to self) Yes, sir.

Q. Can you tell me whether the word "fused" was an amendatory insertion?

A. The word "fused" was not an amendatory insertion.

Q. Thank you very much.

[fol. 436] I would like to direct your attention now to the soft copy of the Adams patent, Trial Exhibit No. 10, and I would like to ask you to state what the reference numeral 10 shown in Figure 1 of this patent designates?

A. "10" designates the container.

Q. Thank you.

Doctor, will you refer to column 1 on page 1, the left-hand column, lines 22 to 25, and tell us what the container is constructed of, what material it is constructed of?

A. I don't find it.

Q. It should be on the first page. It starts at line 24.

A. (Reading) "The container 10 may comprise glass or any other material which is waterproof."

Q. Thank you.

Doctor, I would like to ask you whether you think that a porous, absorbent cloth would serve as a container? In other words, if a porous or bibulous piece of material were used as No. 10 is used here, would you regard that as a container?

A. It would not be a container in the sense of that specific embodiment for that specific drawing.

Q. Doctor, I would like to refer your attention to [fol. 437] the Fischbach Patent No. 2,636,060.

A. I do not have it here.

Q. Can you tell me what Trial Exhibit number it is, Your Honor?

Commissioner Lane: Trial Exhibit No. 2.

Mr. Arseneau: Perhaps I could take the reporter's copy, or do you have an extra copy, Mr. Reilly.?

Mr. Reilly: Yes, sir. (Producing extra copy of Fischbach patent) That is a part of Trial Exhibit No. 1.

By Mr. Arseneau:

Q. In column 1 of Mr. Fischbach's patent, I would like to direct your attention to lines 28 and 29.

A. (Reading to self)

Q. Would you give us your construction of what that passage means?

A. It reads:

> "Fused cuprous chloride involves a number of severe production difficulties, particularly in mass production, due to the necessity of maintaining the cuprous chloride at relatively high temperatures while charging the supporting grids or plates with the fused cuprous chloride."

Q. Will you tell the Court the term which precedes the word "production" in line 29?

[fol. 438] A. "Mass."

Q. Thank you.

Yesterday or the day before, testimony was adduced in connection with certain Plaintiffs' Exhibits Nos. 22, 23, 24 and 25. Doctor, I believe I will place these before you. Here are Plaintiffs' Exhibits Nos. 22, 23, 24 and 25, 25 being in one of the beakers, and I will ask you whether you constructed or made those samples personally?

A. Yes, sir.

Q. I will also ask you, Doctor, under what circumstances or what techniques were used to construct these?

A. Do you mean how I made them?

Q. Yes, sir.

A. I took cuprous chloride and put it in a Pyrex dish, and in this particular case added a powdered carbon. The contents were heated by a gas burner until the cuprous chloride was melted, and the carbon was stirred into it. At that point I took the copper screens and dipped them into the mold, and the cuprous chloride went through them, and allowed them to cool.

Q. I would like to ask you, sir, do you regard the construction of those four samples as mass production?

A. Of course not.

Mr. Arseneau: Your Honor, we seem to have acquired [fol. 439] our copy of Hackh's Chemical Dictionary, and I will turn it over to Mr. Reilly (handing chemical dictionary to counsel for Plaintiffs).

By Mr. Arseneau:

Q. Doctor, I would like to direct your attention to the Chubb Reissue Patent No. 23,883, and ask counsel's indulgence while we identify the trial exhibit number.

Mr. Reilly: It is Trial Exhibit No. 6. Will you give me a chance to find it?

Mr. Arseneau: Surely.

Mr. Reilly: Have you got a copy of that, Doctor?

The Witness: No, sir.

Mr. Reilly: Do you have a copy of it, Your Honor?

Commissioner Lane: Yes, sir, I have a copy of it.

By Mr. Arseneau:

Q. Doctor, in connection with this reissue patent, I would like to direct your attention to the right-hand column, headed "Column No. 2," Lines 40 through at least 49, and I would ask you to take a glance at those.

A. (Examining same) Yes, sir.

Q. Doctor, referring to this recipe and the ingredients set forth therein, can you tell me whether any of the samples which were made by you, or which were used as exhibits, used these constituents and used them in this par-
[fol. 440] ticular way?

A. No.

Q. Can you tell me whether the samples made here, or made previously and entered as exhibits, were made in accordance with the teachings of the Adams patent?

A. I made samples in accordance with the teachings of the Adams patent, and I identified the Adams technique, and identified it as a water liquefaction technique, as referred to by Fischbach.

Q. I wonder if it would be fair to take up this point: that these demonstrations made yesterday in the courtroom would not establish anything as between cells made in accordance with the Adams teaching and cells made in accordance with the teachings of the Chubb patent?

Mr. Reilly: I object to the term "cells made in accordance with the Adams teaching."

I would like to have Mr. Arseneau state what he means when talking about that specific manufacturing method. There are a lot of techniques taught in the Adams patent, and I think he ought to indicate what portion he is talking about, Your Honor. I think there should be a little definition.

Mr. Arseneau: I can shorten it a little bit, Your Honor, so as to please opposing counsel.

[fol. 441] By Mr. Arseneau:

Q. Yesterday, Doctor, during your examination of one of the samples which was subjected to a test, statement was made about taking cuprous chloride and fusing it and

adding carbon, while it was in a molten condition, and then allowing it to cool.

Mr. Reilly: I object to the use of the word "fusing" in that sense, Your Honor.

Mr. Arseneau: Your Honor, let me state the question this way:

By Mr. Arseneau:

Q. Is it true that one of the samples referred to yesterday was constructed, or at least the electrode was constructed by heating up cuprous chloride and allowing it to cool on the mesh?

A. Yes, but these samples were merely to illustrate to the Commissioner the basic thing which we are talking about, water-activated batteries. They were not tests.

Q. Doctor, you have answered the question. I don't think it was the one I asked but I will leave it in the record.

Is it true, referring to those cells which are set up on the Court bench here, that as between these two cells or two units, that none of them were made by using the recipe or constituents of the cells as set forth in Chubb? [fol. 442] A. Yes.

Q. Thank you.

Doctor, you testified yesterday in response to a question that the Stokes machine had a capability of several thousand pounds per square inch. Can you tell us what experience you have had with the Stokes melting machines?

A. I gave the range of a couple of hundred pounds that it served.

Q. I understand.

A. In that period of my life I was one of the organizers of an organization called the Powder Metallurgy Association, which had to do with the early experimental work on the application of metals going into engineering parts, and in that connection we had considerable familiarity with the Stokes machine, in a wide variety, and much of the work which was done in my laboratory and work was done for organizations like the Chrysler Corporation, Ray Products and the Clark Company.

Q. I understand. Doctor, the next thing I am going to direct your attention to is Mr. Fischbach's Patent No. 2,636,060.

Commissioner Lane: Trial Exhibit No. 2.

By Mr. Arseneau:

Q. And I will also direct your attention to the Chubb [fol. 443] Reissue Patent No. 23,883, and also to the Pucher Patents Nos. 2,640,090 and, I think the other is, 2,640,091.

Commissioner Lane: The Pucher patents are Trial Exhibits Nos. 3 and 4.

Mr. Arseneau: Actually there are three Pucher patents.

By Mr. Arseneau:

Q. Doctor, I would like to ask you the following question in connection with references to these patents:

Can you tell me with respect to any of these if the cuprous chloride electrode was formed by heating cuprous chloride up to a molten state and pouring it into a mold and allowing it to cool?

A. No, sir, it was not.

Q. Thank you very much. The next exhibit which I would like to refer you to is identified as Trial Exhibit No. 15, page 15. I think it is a letter to Mr. Kettering.

Mr. Reilly: I will have to find that.

(Discussion off the record.)

Commissioner Lane: Back on the record.

By Mr. Arseneau:

Q. Doctor Mantell, in this Trial Exhibit No. 15, on page 2, at the top of the page, there is the caption "Characteristics Of Neutro Cell," and there is a sentence there to the effect that it can be stored indefinitely [fol. 444] without alteration or loss of power until the moment it is used.

I think Mr. Reilly yesterday asked you if you knew

of any other cells, or any cells other than the Adams type cells, which had this capability?

Mr. Reilly: I deny that.

Mr. Arseneau: Are you referring to a slight change in verbiage, or to the entire question?

Mr. Reilly: I did not ask that question.

By Mr. Arseneau:

Q. There is a sentence here, Doctor Mantell, that the cell can be stored indefinitely without alteration or loss of power until the moment it is used.

Does that differ in any respect from a car battery or a battery which is placed on a shelf?

A. A lot of batteries can be stored indefinitely.

Q. I would like to refer you to the very last paragraph on page 2 of the "Characteristics of Neutro Cell," and I would like to ask you whether you personally have tested at 40 degrees below Fahrenheit a cell which is constructed of fused cuprous chloride, either as you say it is narrowly defined in Adams, or in any other way?

In other words, have you personally taken a magnesium cuprous chloride cell and treated it at 40 degrees [fol. 445] Fahrenheit below and, as a starting question, I say, by any method?

A. Yes, sir.

Q. And particularly have you taken a cell comprised of magnesium and cuprous chloride and then melted and cooled it and tested it at 40 degrees Fahrenheit below?

A. No.

Q. Thank you. I would like to refer you now to page 3 of the same trial exhibit, if I may. There is a numbered paragraph "1", which talks about emergency source of light and power on submarines, warships, etc., do you recall testifying yesterday to having knowledge of this through this application?

A. Whether I had knowledge of the application?

Q. In other words, did you testify yesterday that you knew that these applications had been made for the neutro cell?

A. Not for the neutro cell but for cells which are

equivalent to the neutro cells, which are commercial, and which meet the definition.

Q. May I ask, Doctor, which submarines or warships you have seen such cells on?

A. When testing at Grotton, Connecticut. It might have been in connection with Baker Platinum Company and the cathodic protection of hulls.

[fol. 446] Q. You say the cell which you saw at Grotton, Connecticut, is the type of cell which you regard as equivalent to Adams' neutro cell?

A. Yes, sir.

Q. Can you tell us when you witnessed this test at Grotton?

A. Oh, I think it was about four years or so ago.

Q. Doctor, yesterday you testified I believe in connection with Trial Exhibit No. 7 and Trial Exhibit No. 8 and Trial Exhibit No. 9 that they would operate substantially the same regardless of whether the plate contained thereon was a pasted type plate or was a plate formed by fusion in the normal sense used in the Adams patent.

Mr. Reilly: I object to the conclusion of law. Mr. Arseneau keeps using the word "fused" in asking questions.

Mr. Arseneau: Let me word it differently.

By Mr. Arseneau:

Q. Doctor Mantell, do you recall testifying yesterday in connection with Trial Exhibits Nos. 7, 8, and 9, that substantially the same performance could be obtained regardless of whether they were made up the way they are or whether they were made by the use of cuprous chloride which was heated and subsequently cooled?

A. In fact what I testified to was that they were essen-

[fol. 447] tially all the same systems, and that these variations of the system and the performance of the system would be substantialy the same.

Q. I would like to ask you if you have ever constructed any cells which are like Trial Exhibits Nos. 7, 8, and 9, which are substantially identical except for the use of a plate which was formed by heating cuprous chloride and allowing it to cool?

A. I have not.

Q. Thank you.

Doctor, I would like to ask you this: Did you yesterday construct a cell in the courtroom of the magnesium-cuprous chloride type cell, in which the cuprous chloride electrode was formed by melting and being allowed to solidify?

A. Yes, sir.

Q. Did you construct a magnesium-cuprous chloride type cell in which the cuprous chloride was made from a paste, pasted on a wire mesh or grid?

A. Yes.

Q. Did you equip each such battery with a bulb and place it on the Court's desk?

A. Yes.

Q. Did the lamps burn for each cell?

A. Yes.

[fol. 448] Q. What conclusion do you draw from this, Doctor?

A. There is no conclusion to be drawn. It was merely illustrative, to illustrate to His Honor what the cells would do.

Q. It is your position that the samples which were placed on the Court's desk yesterday, then, were not for the purpose of showing the comparison of any comparative value, between different types of cuprous chloride?

A. None.

Mr. Reilly: Your Honor, with reference to the demonstrations and the conclusions, let us treat those matters in brief and final argument. I do not think the witness is qualified to draw a legal conclusion from the demonstrations made.

Mr. Arseneau: May it please the Court, the witness is qualified as an expert electrochemist, and in the construction of electrolytic cells, and he had these in Court, and I believe the question as to the conclusion he draws concerning the cells is perfectly proper, and I do not believe it calls for a legal conclusion.

Commissioner Lane: I think he has given his opinion, that it does not prove anything.

Mr. Arseneau: That is correct, and I did not intend to pursue that aspect of it any further.

[fol. 449] I think I would like to ask Mr. Reilly at this

time what his position is with respect to the excerpt from the Hackh's Chemical Dictionary, which was marked for identification this morning.

Mr. Reilly: No objection.

Commissioner Lane: Defendant's Exhibit No. 2 is received in evidence.

(The document heretofore marked for identification Defendant's Exhibit No. 2 was received in evidence.)

By Mr. Arseneau:

Q. Doctor, do you recall testifying this morning that magnesium was known as electrode material prior to the time of Mr. Adam's patent?

A. Yes, sir, and it had been suggested, largely theoretically.

Q. Do you recall advising that there was a tendency on the part of magnesium to corrode?

A. Yes.

Q. And that—and I think you will agree with this when I say it—in your opinion would have militated against its use in this type of battery?

A. I did not say that it was my opinion, but it was something which I would agree with.

Q. Will you tell us under what circumstances the mag- [fol. 450] nesium tends to corrode, what causes it to corrode?

A. The reaction with electrolytes and the reaction with water, and the reaction wtih acid bases.

Q. If you have a reserved type cell, and the cell is kept without fluid until used, what would tend to corrode the magnesium electrode then?

A. Moisture in the air, as in Exhibit No. 8.

Q. Would the moisture in the air also tend to attack cuprous chloride in the cuprous chloride system?

A. Yes, sir, it could.

Q. Can this be guarded against in a cuprous chloride system?

A. It can be guarded against but it might be in the cell proper.

Q. Thank you.

Doctor, at this time I would like to refer you to what

I believe is Commissioner's Exhibit No. 2, Proceedings of the Tenth, Eleventh and Twelfth Battery Research and Development Conference.

A. I have them here, Mr. Arseneau.

Q. Doctor, I would like to direct your attention to the Proceedings of the Tenth Annual Battery Research and Development Conference, and in that article, sir, I would like to direct your attention to page 25, and I am referring [fol. 451] now more particularly to the left-hand column, to the lower-most paragraph of the left-hand column, and more specifically yet I am referring to the sentence in this paragraph which reads:

> "The stock strip is pasted on a bronze wire screen . . ."

Do you have that?

A. I have it.

Q. I wish to ask you whether, in your opinion, in view of your previous testimony, you regard this technique or this method of pasting as falling within the definition of "fused," which you have used up until now?

A. Yes.

Q. Thank you very much.

Mr. Reilly: Mr. Arseneau, I would like to understand this. I do not understand the question. The sentence reads: "For instance, work is now being conducted with materials to make possible the preparation of dense, highly reactive cuprous chloride positives with properties similar to the silver chloride properties."

Mr. Arseneau: Silver chloride, right. Then it says:

> "The stock strip is pasted on a bronze wire screen, whereas the new product does not necessarily require an imbedded grid."

[fol. 452] All I am asking Doctor Mantell is whether he regards this reference to pasting as falling within the definition given heretofore by him of "fusing."

The Witness: Let me answer——

Mr. Reilly: Let me finish my statement, please.

What I am asking for is the reference to the "stock strip is pasted on a bronze wire screen" has no relation

to this product which does not require an imbedded grid.

I am wondering if you are misinterpreting the reference to a stock strip being pasted, and you think it refers to the technique in research development. That is, it is a new product as distinguished from the other method.

Mr. Arseneau: I would say that all I am asking the doctor is whether this reference to "the stock strip is pasted on a bronze wire screen" falls within the meaning of "fusing" that he has used here.

The Witness: Let me answer——

Mr. Reilly: It says: "The stock strip is pasted on a bronze wire screen, whereas the new product does not necessarily require an imbedded grid."

And I do not know why we are going into this reference when the thing has been so adequately described. Do you interpret those five or six words as a strip of copper wire on which cuprous chloride combined with water and [fol. 453] allowed to dry If so, I have no objection to the question, but you are picking out just a part, and you must have some reason.

Mr. Arseneau: Let me ask a question.

By Mr. Arseneau:

Q. Do you feel that you understand the question, Doctor?

Mr. Reilly: I am not interested in what the witness feels.

Mr. Arseneau: I am not interested in testifying.

Mr. Reilly: I would like to know, Your Honor, if this phrase which was chosen relates to the product I have described, and, if it does, I wish he would describe the product so that the witness can testify to it without a chance of ambiguity.

It may be that Mr. Arseneau knows what he wants, but I would like to be able to understand what is intended.

Commissioner Lane: I do not understand the question, and I think a little clarification would help, Mr. Arseneau.

Mr. Arseneau: Your Honor, we will let the record stand where it is on that and pass on.

By Mr. Arseneau:

Q. Doctor, I would like to refer you in this same exhibit to the Proceedings of the Eleventh Annual Battery Re-

search and Development Conference, and there is an article [fol. 454] in there by Mr. E. M. Morse, which I think starts on page 69. Do you mind glancing at that?

A. Yes, sir. (Examining document)

Q. There was estimony about this morning, and there was also testimony, I believe, about the material on page 70, and I would like to direct your attention to the paragraph in the left-hand column, directly beneath Figure 4.

A. The left-hand column?

Q. Yes, sir, the left-hand column.

Mr. Reilly: On page 70?

Mr. Arseneau: Yes, sir.

The Witness: Figure 4 is not on page 70.

By Mr. Arseneau:

Q. I understand. I stand corrected. It is on page 71, sir. Will you turn to page 71, the last sentence in that paragraph and read it?

A. "A milling time of four minutes at 260° F. has been found to yield the most desirable plate."

Q. Doctor, I am not going to trouble you with Fahrenheit and Centigrade conversion, but can you tell us again what is the melting point of cuprous chloride?

A. 422° Centigrade.

Mr. Arseneau: Your Honor, I wonder if there would be any objection to taking a five or ten-minute recess at this [fol. 455] time?

Commissioner Lane: We are due for a ten-minute recess right now.

Mr. Arseneau: Thank you.

(Short recess.)

Commissioner Lane: You may continue, Mr. Arseneau.

Mr. Arseneau: Thank you.

By Mr. Arseneau:

Q. Doctor Mantell, this morning I asked a question concerning cuprous chloride particles and granules which were mixed and one time I mentioned toluene and the other time I mentioned water, and I asked what happened to the spaces where the water had previously been after the water

was gone, and I think your answer was that if the drying process was rapid, that there would be voids, and there would be porosity there.

A. Yes, sir.

Q. Considering that it was made in that manner and with these interstices so that something could get into the pores some way or other, I would like you to consider that, and, on the other hand, consider the electrode that was not quite so porous but was far more dense. Can you tell between two such types which cell should have the highest internal resistance?

[fol. 456] A. The internal resistance would not be one of the functions or factors.

Q. All other things being equal, I should say, sir.

A. All other things being equal?

Q. And having the variables, that one CuCl electrode would be more porous and a different CuCl electrode would not be.

A. In general, one might have a lower basis.

Q. Let me ask you as to which of these would have the lower current density, I mean having the same current from either cell?

A. The more porous one might have the lower current density, but it would not be substantially different.

Q. Can you tell me in your opinion which of these cells would have the greater terminal volts under load? In other words, carrying current, which of these cells would have the greater terminal voltage available?

A. I can't answer your question now because there are so many other factors.

Q. I understand. Can you tell me what the other complicating factors are?

A. The electrode, spacing the electrolyte, and the other characteristics of the cell, and what you are going to do with it, and how you would designate it.

[fol. 457] Q. If the electrodes are spaced the same and the electrolytes are the same, and one is a little more spongy or porous than the other one, which in your opinion would have the greatest terminal voltage under load?

A. The one which is more porous might have the greater voltage under load, but not substantially.

Mr. Arseneau: Your Honor, I think that concludes our

cross-examination of Doctor Mantell. Thank you very much, Doctor.

The Witness: Thank you.

Commissioner Lane: Will there be some redirect examination?

Mr. Reilly: I have on or two questions, if I may, Your Honor.

Commissioner Lane: Proceed.

Redirect examination.

By Mr. Reilly:

Q. Doctor, are the electrochemical characteristics of cuprous chloride the same when liquefied with water as when it has been liquefied with heat and unified?

A. They are the same substantially.

Q. Doctor, in the Niaudet article, Defendant's Exhibit No. 1, on page 202 you have been referred to a matter which I want to ask you about.

[fol. 458] I will show you my copy, which is unmarked, and referring to page 202, you referred this morning to this statement:

> "In the beginning of his researches, this physicist used chloride of silver in the shape of a powder or paste. . . ."

You were asked to comment about the paste.

Doctor, what kind of an electrode do you get out of silver chloride in the shape of a powder?

A. You put it in a bag and have the bag surrounding the contacting electrode.

Q. Doctor, you say that silver chloride powder could be in a bag. Why would anyone want to put it in a bag, when this article shows that there are methods for unifying it into one structure without using a bag?

A. I don't know why they might want to put it in a bag, but for a long time a variety of dry battery was made by the bag construction, because it suited a certain mass production operation.

Q. Doctor, in the bag method, do you regard that as in any way following the steps of mixing or blending, liquefaction and solidification?

Mr. Arseneau: May it please the Court, I do not think there is anything left to say but "yes," on that, and I do [fol. 459] not think it is proper rebuttal to the cross, and I object to the question.

Mr. Reilly: If the witness says "yes," I will fall off this chair.

Mr. Arseneau: We do not want that to happen.

Mr. Reilly: Read the question, please, Hr. Reporter.

(Question read.)

The Witness: No, it is not.

Mr. Arseneau: I said there was very little left for the witness to say but "yes" or "no."

By Mr. Reilly:

Q. Doctor, can you increase the porosity of a melted-by-heat cathode by the addition of carbon?

A. Yes, sir, if you select a specific form of carbon.

Q. What specific form of carbon do you have in mind, Doctor?

A. I am thinking of some of the activated wood carbons or activated carbons from the paper industry, and you will get such a high degree of porosity, if you use those, that you will have considerable difficulty in forming an electrode.

Q. In other words, you get enough to create an over-porous electrode?

A. Yes, sir.

Q. Can you add sufficient to form a porous electrode?

[fol. 460] A. Yes, sir.

Q. Doctor, in one of the physical Army batteries, which I think are among Exhibit Nos. 7, 8, or 9, if the spacer material between the cells were made of something such as spun glass, and you dunked it in water, would the spun glass function as a sponge and retain water?

A. It would function as a sponge and retain water.

Mr. Reilly: That is all.

Commissioner Lane: Any further cross-examination?

Mr. Arseneau: No, Your Honor.

Commissioner Lane: You may step down, Doctor. Thank you for your testimony.

(Witness excused.)

Commissioner Lane: Any further witnesses for the Plaintiff's prima facie case?

Mr. Reilly: No, Your Honor, our case is in, so far as the testimony is concerned.

Commissioner Lane: Off the record, please, Mr. Reporter.

(Discussion off the record.)

Commissioner Lane: Back on the record.

Mr. Arseneau: Your Honor, I guess we will go ahead with our first witness.

Commissioner Lane: Call your first witness, Mr. Arseneau.

[fols. 461-482] TESTIMONY FOR DEFENDANT

Mr. Arseneau: All right, but before calling him I would like to lay out the exhibits.

Commissioner Lane: Very well.

(Pause in the proceedings)

Whereupon HOWARD RAYMOND KNAPP, a witness produced on behalf of the Defendant, being first duly sworn by said Commissioner, was examined and testified as follows:

Direct examination

By Mr. Arseneau:

Q. Mr. Knapp, I wonder if you would give the reporter your name and your present address?

A. My name is Howard Raymond Knapp and I live at 56 William Street, at Red Bank, New Jersey.

Q. Will you tell us where you are presently employed?

A. I am presently employed at the Fort Monmouth, New

Jersey, United States Army Signal Research and Development Laboratories.

Q. Will you give us your title or your professional designation and the department?

A. I am Chief of the New Systems Technical Area in the Special Purpose Battery Branch of the Power Sources Division.

. . . . . .

[fols. 483-506]

Transcript of Testimony for Defendant (Resumed)—

July 14, 1961

* * * * * * * * * * *

[fol. 507] Cross-examination

By Mr. Reilly:

Q. When were you born, Mr. Knapp?

A. August 31, 1921.

Q. When did you start in college?

A. In September 1939.

Q. When did you graduate?

[fol. 508] A. December 1942.

Q. How old were you at that time?

A. 21.

Q. Where did you go after that, Mr. Knapp?

A. For a year after that I remained in Providence College as a graduate assistant in the Department of Chemistry. I was employed by the College.

Q. That was in 1943?

A. During 1943, yes, sir.

Q. Then what did you do?

A. I entered graduate school at New York University, as a teaching fellow, early in 1944, in January or February, and I pursued my graduate course until 1947.

Q. As a full-time student?

A. It would be a part-time student and part-time teaching.

Q. Did you have any other jobs?

A. Not until 1946.

Q. What did you do then?

A. I became employed by the P. R. Mallory Company, the Battery Division in North Tarrytown, New York.

Q. How long did you stay with them?

A. For about two and a half years, in February 1949.

Q. And after February 1949 where did you go?

[fol. 509] A. I went to the Oakite Corporation in New York.

Q. What do they manufacture?

A. They manufacture detergents and cleaners.

Q. How long were you there?

A. One month.

Q. What happened?

A. I got a job at Fort Monmouth. I left the P. R. Mallory Company because I was living in Brooklyn, and North Tarrytown was about 35 miles up the river from New York City, and in 1948 I was married, and this gave me too much driving going to North Tarrytown every day, and I was looking for a job.

I had met somebody from P. R. Mallory, and I mentioned that I was looking for another job, and I got a telephone call about two weeks after that asking me if I wanted to come down and see them about a job at Fort Monmouth, and I did go down for an interview and I was satisfied with the set-up and I gave Oakite two weeks' notice, and that is why I was there only for a month.

Q. Where is it located?

A. It is located on Thames Street.

Q. Who called you from Fort Monmouth?

A. Mr. Ellis.

Q. Whom did you interview when you went there?

[fol. 509a] A. Mr. Daniels and Mr. Ellis.

Q. Who are those people at the present time?

A. Mr. Daniels is our Division Director, and Doctor Fischbach is my immediate superior, and is the Branch Chief of the Special Purpose Battery Branch.

Q. You are one of Doctor Fischbach's assistants?

A. I am one of his subordinates. I wouldn't say I am one of his assistants because we have an Assistant Director, Doctor Mandel.

Q. Why did you undertake to perform these experiments, Mr. Knapp?

A. I was requested to.

Q. Who requested you to?

A. Mr. Arseneau came to the laboratory.

Q. Did he come to you directly?

A. No, I don't know who he came to directly, but I know he saw several people before he spoke to me.

Q. You had some special qualifications?

A. At the time I was in charge of the Water-Activated Battery Program in the Special Purpose Battery Branch.

Q. Who introduced you to Mr. Arseneau?

A. I am not sure. Mr. Frankel was there and Mr. Prouty, but I am not positive who introduced me because there were several people around.

[fol. 510] Q. What did Mr. Arseneau request you to do?

A. We had a discussion as to whether I thought there was anything distinguishing between or any way to tell the difference between the battery made by Mr. Adams and a battery procured, or something along that line.

Q. You were looking for a way to distinguish them?

A. Yes, sir.

Q. Had you ever seen the battery electrode made by Mr. Adams?

A. I had not, no.

Q. Did you ever discuss the battery electrodes made by Mr. Adams with anybody at Fort Monmouth?

A. No, I never did.

Q. Did you ever discuss this matter with Doctor Mandel?

A. No.

Q. Or Doctor Fischbach?

A. No, but I heard vague talk about the Adams case, but I had never discussed any of the pertinent points of manufacture.

Q. Did you ever see any test reports at the Fort Monmouth Laboratories concerning the Adams battery?

A. I have never read the reports, but I remember seeing something about Adams. I never saw any of the reports on the Adams battery.

[fol. 511] Q. How extensive were they?

A. There were one or two folders marked "Adams."

Q. Just one or two folders?

A. Yes, sir.

Q. 40, 50 or 60 pages?

A. I do not know. I could not tell you how much they contained.

Q. You never looked inside them?

A. I never read them. I glanced at the papers but I could not tell you how many there were.

Q. Was there more than one page?

A. There was more than one page.

Q. There was at least one page in each folder?

A. Yes, sir.

Q. Five pages?

A. I said I just glanced at them and I did not count them or pay any attention to them.

Q. Certainly less than 10?

A. I could not say that. There were several pages in each folder.

Q. Would you say there were more than ten?

A. I could not say that.

Q. Why do you suppose there were two folders?

A. I don't know.

[fol. 512] Q. Was there a Section A or Section B on a different subject?

A. I saw the folders lying in a drawer in the laboratory and they were not in a file or anything but just in the drawer.

Q. Whose drawer?

A. I believe Mr. Saunders' drawer, who is deceased.

Q. How long had they been there?

A. I have no idea.

Q. When did you see them?

A. Probably within the last ten days or so.

Q. How long had Mr. Saunders been deceased?

A. Since December of last year.

Q. They had been sitting in the drawer there?

A. In the laboratory, yes, sir.

Q. You say you had a copy of the Adams patent?

A. Mr. Arseneau gave it to me.

Q. Do you have that copy with you?

A. No.

Mr. Arseneau: You can look at the Trial exhibit, if you need to, Mr. Reilly.

By Mr. Reilly:

Q. I wonder if you have the patent that you worked from?

A. I don't have it now. I don't know where it is but [fol. 513] it is among the papers here somewhere.

Q. It is among the papers which are here?

A. Yes, sir, but it is indistinguishable. There were several Adams patents and I am not sure which one I had.

(Major Richwine at this point handed paper to witness.)

By Mr. Reilly:

Q. Is any of your handwriting on that?
A. No, sir.
Q. Any of your markings on that?
A. No, sir.
Q. Have you ever seen this copy before?
A. Oh, yes.
Q. Is this the one you saw before?
A. No.
Q. This is a different copy?
A. Yes, sir.

Mr. Arseneau: Here are some more which you can try.

(Producing papers)

By Mr. Reilly:

Q. Major Richwine, do you have the copy with which this gentleman worked?

Major Richwine: I have not seen any copy, but this particular copy is from one of my files.

Mr. Reilly: Does anybody know where it is?

Major Richwine: We have been using this for several [fol. 514] days.

By Mr. Reilly:

Q. Do you know where it is Mr. Knapp?
A. No, sir, I do not know where it is.
Q. Do you have a copy in front of you of that patent?
A. I have a copy here.
Q. How does Mr. Adams in his specific embodiment teach the manufacture of his electrode?
A. Mr. Adams teaches that you place cuprous chloride in a crucible, and a piece of wood carbon is placed on the top, and the material heated to a temperature between 400 and 500 degrees Centigrade.
Do you mean, how does he make the electrode?
Q. Yes, sir.
A. The material is then poured into a mold and it is cooled and dipped into a Baume solution of sulfuric acid, and while still wet, the electrode is covered with aluminum powder.

Q. Is that what you did?

A. Exactly.

Q. Exactly?

A. I used a Pyrex test tube as both the crucible and the mold, and I heated the material up to a temperature, and I put some powdered wood charcoal on the top surface, [fol. 515] about a quarter of an inch of charcoal on the top surface of the cuprous chloride in the test tube, and I heated it up to a temperature of between 400 and 500 degrees Centigrade, and I allowed the material to cool, and then used the slug.

Q. How big a test tube did you use?

A. About six or six and a half inches.

Q. How wide?

A. Probably——

Q. One-half inch?

A. Maybe a half inch or a little more than a half inch.

Q. When you put in 15 grams of cuprous chloride, how full was the test tube?

A. Probably a little more than half full.

Q. When you had melted it, how full was it?

A. Now maybe less than a quarter full.

Q. An inch or an inch and a half high?

A. Yes, sir.

Q. It was a pretty small sample, was it not?

A. Yes, sir.

Q. Did you only make one sample?

A. I made several samples.

Q. Oh, you made several samples?

A. Yes, sir.

Q. Several test tubes full?

[fol. 516] A. I made them in the same way, but I did not weigh out the material sometimes.

Q. I am interested in the number of test tubes you made.

A. I made five or six, but I don't recall exactly the number.

Q. I only find two reports in here.

A. Yes.

Q. What did you do with the rest of them?

A. Chopped them off.

Q. Did you test them?

A. No, I did not test them.

Q. What did you do about the notes in connection with chopping them off?

A. I did not have notes. I put the material in a test tube and heated it up. What I was trying to do was to determine techniques, to see how the material acted.

Q. You threw those samples away?

A. Most of them. I probably still have some of the pieces up at the laboratory.

Q. You still have some back at the laboratory?

A. Yes, sir.

Q. Does Adams teach this business of putting the cuprous chloride and vacuum-drying it and raising the tem- [fol. 517] perature for two hours under a vacuum?

A. No, that is a standard drying procedure.

Q. You dried the material first? Then you placed the 15 grams of material in a Pyrex test tube?

A. That is correct.

Q. Tell me, Mr. Knapp, how did you decide to write this one up and not some of the other five?

A. I told you I did not take the exact weights of the others, and hence there was no writing up to do. I could not have written them up as well as this.

Q. But you wrote these up contemporaneously as you were working, did you not?

A. Yes, sir.

Q. So here you were doing something before you took the exact weights?

A. I don't follow up.

Q. When you were putting these things in the vacuum and heating them up, it was before you took exact weights, and I am suggesting that you might have made some notes along the same line as these, even before you had gone to the trouble of weighing the samples.

A. To answer you, I wanted to use the standard sample of material. I therefore will say that before this I had not dried the material. In other words, I took samples [fol. 518] out of the bottle and attempted to find out and I had never fused a sample of cuprous chloride prior to these tests.

Q. You had never mixed one with water?

A. I had never mixed one with water?

Q. Yes, sir.

A. Maybe while Mr. Frankel was there, but I did not previous to the last.

Q. Go ahead.

A. Go ahead with what?

Q. I thought you were telling me about the other test tubes full of material.

A. The material tests which I made were just superficial tests to see what happened when you heated the copper chloride in a test tube.

Q. And when you looked at it, you threw it away?

A. Yes, but we probably have some of the samples in the laboratory. I took no data on them and therefore I did not consider the samples of being of particular value for exhibition to you learned gentlemen.

Q. In other words, it is only by looking at your notes that you know what the sample was, and it tells you what the report was. You don't take the notes from the sample but you seem to have a reverse process. In any event, these notes do not give information concerning all the [fol. 519] samples of cuprous chloride which you made?

A. That is correct.

Q. After you did that you put the material in a test tube and you put the layer on top, what you call wood charcoal?

A. That is correct.

Q. Did you ever try using activated charcoal or carbon?

A. Activated charcoal?

Q. Activated carbon.

A. I have used activated carbon.

Q. In cuprous chloride?

A. I don't recall whether I used the cuprous chloride or not, but it is quite possible that I did before I found the wood carbon.

Q. That would occur to you as a possible type of carbon to use?

A. No, it would not.

Q. But you used it?

A. I used it because that is all I had at the time. That is one of the reasons I did not use it, I was not sure it was wood charcoal, and it was only when I got a sample of wood charcoal that I started recording it.

Q. You did not want to use activated wood charcoal?

A. That is not what I said.

[fol. 520] Q. I am asking the question.

A. I didn't want to use activated wood charcoal?

Q. Yes, sir.

A. Not according to Adams. I do not think he says anything about activated charcoal here, but has a piece of charcoal, and that means a single piece, and I didn't have a single piece, and I used the powdered material.

Q. But in one of these samples you used activated carbon?

A. Yes, sir.

Q. Was the cuprous chloride melted by heat when you used the activated carbon?

A. Yes, sir.

Q. What did you observe occurring?

A. What did I observe occurring?

Q. Yes, sir.

A. I noticed that there was sort of a spontaneous combustion of the carbon, as the temperature went up.

Q. Anything else?

A. Anything else?

Q. Yes.

A. As I said, I made several samples, and I am trying to recall.

Q. Can't you remember which one it was?

[fol. 521] A. With most samples there came a small spontaneous combustion with the test tube, but I don't remember specifically anything different happening with activated carbon than with the other.

Q. Let me ask this: You told me before that when you put the cuprous chloride powder in the test tube, it was how full?

A. Probably one-half full.

Q. As it melted it went down in the test tube?

A. It went down, but how far I did not measure.

Q. When you had the activated carbon in the test tube with the cuprous chloride, did you notice any apparent change in the volume of the cuprous chloride as it melted?

A. I imagine it went down. I don't recall it going up at any time.

Q. You did not see it go up?

A. Not the cuprous chloride.

Q. I am talking about the mixture, whatever it was, in the test tube. Did it go up or down, or don't you remember?

A. I can't remember, but some of them went up, I think.

Q. Some of them went up, you think?

A. Yes, sir, but I don't recall which one.

Q. Were they melted when they went up?

A. There was some sort of reaction, on at least the top [fol. 522] surface.

Q. This one which we have in evidence, this one piece, that is the one which went down?

A. That is right.

Q. This sample is a sample from the test tube experiment on page 1, is that correct?

A. I will look (examining book). Yes.

Q. Where is the sample from the other experiment?

A. What other experiment?

Q. Well, are there not two on page 5?

A. Yes.

Q. It is the other one that I am talking about. Where is that sample?

A. Do you know what happened to it, Mr. Arseneau?

Q. I am not interested in your asking him. Do you know what happened to it?

A. I am not sure.

Q. Did you give all the samples to Mr. Arseneau?

A. Most of them, but I have some back in the hotel room.

Q. You have some more, Mr. Knapp?

A. Yes, sir.

Q. Do you have the others back in the hotel room?

A. I am not sure.

[fol. 523] Q. How many other samples do you have back in the hotel room?

A. Probably three or four.

Q. I will want those after lunch.

A. Not fused.

Q. When you say "fused," you are using it in the sense, I take it, of liquefying by heat and solidifying by the removal of heat, and you are not talking about any other liquefaction?

A. When I say "fused," I mean liquefied by heat and solidified.

Mr. Arseneau: May it please the Court, to expedite things, we have no objection to producing the other samples which Mr. Reilly requested.

Mr. Reilly: Thank you, Mr. Arseneau. I did not assume you would have.

By Mr. Reilly:

Q. When you melted this material, it increased in volume as it melted?

A. Yes, sir.

Q. You left it alone and let it cool into a solid?

A. That is correct.

Q. You are aware, of course, that the Adams patent in lines 9 et sequitur, says that the cuprous chloride is heated [fol. 524] to a temperature at which it may be poured?

A. That is correct.

Q. And then the mold is supplied with the amount of cuprous chloride poured from a crucible?

A. Yes, sir.

Q. You will note the statement is that he is doing this so that he can pour it. Why didn't you follow that and pour it from your test tube into another?

A. I did not really see any difference whether I left it in one test tube to cool down or put it in another test tube to cool down.

Q. Have you ever mixed up Alka Seltzer by using two glasses, or seen a druggist do it?

A. Yes, sir.

Q. Do you think pouring has a mixing function?

A. Yes, but in this case Mr. Adams says a piece of wood carbon, and I do not think you can mix it with a piece of wood carbon and do that.

Q. What if you pour it?

A. You still have a piece of wood carbon.

Q. Do you always have a piece of wood carbon?

A. If you have it at high temperature, you will have carbon monoxide.

Q. You found it difficult to pour, following what you [fol. 525] understood to be the specific description?

A. It did not occur to me to pour it.

Mr. Arseneau: I object. It is not important what he tried to do.

By Mr. Reilly:

Q. Did you use a powdered wood carbon or solid, or what?

A. I used a powdered carbon.

Q. You could have poured it easily, if you wanted to, couldn't you?

A. Yes.

Q. Did you ever make any samples by pouring?

A. No, sir.

Q. You left the test tube in the heating unit?

A. No, I took them out of the heating unit and put them into a test tube.

Q. And let them cool there?

A. Yes, sir.

Q. When you had the carbon in the test tube, either before or during the time of the testing process, did you ever stir it in?

A. Not to the extent you indicate.

Q. How long have you been working in the field of batteries?

[fol. 526] A. Six years.

Q. Are you famiilar with the use of carbon in water-activated batteries?

A. Yes, in some of them.

Q. Is that carbon relatively uniformly dispersed?

A. It is relatively uniformly dispersed.

Q. Sort of mixed up?

A. Yes, sir.

Q. I know that Mr. Adams is far from being a battery engineer, but when you find a teaching concerning putting carbon in to act as a catalytic agent, didn't it ever occur to you to mix it?

A. In the case of the Adams statement, the way I understood the use of wood carbon, it protected the cuprous chloride from oxidation, and I did not think that the use of it meant that it was supposed to be dispersed through the cuprous chloride.

Q. When he said it was a catalyst, you concluded he did not know what he was talking about?

A. When he said it was a catalyst, I didn't understand what he meant in that instance.

Q. Because you never understood the function of carbons in one of these systems to be that of a catalyst?

A. That is correct.

[fol. 527] Q. Or have you?

A. No, sir.

Q. Do you believe it has any catalytic action?

Mr. Arseneau: Your Honor, I think broad leeway should be allowed on cross-examination, but to my mind this is outside the scope of direct entirely.

Mr. Reilly: How is that? This gentleman testified that he followed the Adams patent, and I am trying to find out what a man skilled in the art, as he is, would understand about the Adams patent.

Mr. Arseneau: I do not think he gave any interpretation to [illegible] reference to a catalyst, but I will withdraw the objection.

The Witness: I would not regard carbon in a battery plate as a catalyst.

By Mr. Reilly:

Q. What function would it perform?

A. It can perform two functions, depending on the type of carbon used, and one function is to provide conductivity for the material, and the other could form porosity.

Q. Did you know this before you performed these experiments?

A. Yes, sir.

Q. Can you tell us this: You testified that when you [fol. 528] started here the objective was to find a distinction between Adams and some other material. You stated that you understood a function of carbon to be adding porosity?

A. Yes, sir.

Q. Now you had powdered carbon on top of the cuprous chloride?

A. That is correct.

Q. If you had mixed it in, do you believe it would have added porosity?

A. That would be strictly conjecture. Do you want me

to conjecture, because I do not know whether it would have imparted porosity to this particular plate or not.

Q. In what type of a mixture does it impart porosity?

A. In a spongy mixture it will impart porosity.

Q. What?

A. Battery material, for example in a dry cell, where the magnesium dioxide is mixed with carbon and loosely held, a bobbin type structure, and here carbon is used to impart conductivity.

Q. Only?

A. No, it is also used to absorb electrolyte.

Q. Is that the equivalent of porosity?

A. Is that the equivalent of porosity?

Q. Yes, sir.

[fol. 529] A. It could be the equivalent of porosity. It is not exactly because these bobbin type structures are also a spongy material in the first place.

Q. So if something absorbs an electrolyte, it is not necessarily porous?

A. Oh, yes, it is.

Q. If this carbon is to absorb the electrolyte, it has to be?

A. Yes, sir.

Q. So carbon in the structure does add porosity?

A. Not using the generic term "carbon." Carbon comes in all sizes and shapes, and Doctor Mantell described it. A diamond is carbon, graphite is carbon, and if you use Shawinigan black, then it has a certain structure and will more fully absorb it, and graphite will not impart any of this absorption capability to a mix.

Q. How about powdered wood carbon?

A. I have never tried powdered wood carbon.

Q. Really?

A. No, not as a mixture with battery mixtures, and I could not tell whether it would impart porosity.

Q. So it is possible that the wood carbon could impart porosity, but we do not know for sure?

A. That is right. If it were dispersed throughout the [fol. 530] whole material, there would be some which would be dispersed, but Adams says just one piece.

Q. You took a look at Adams and you recalled that he

said a piece, and when he said use a piece, you did not think he meant powdered?

A. Yes, sir.

Q. That is why you used powder in the test tube?

A. I didn't have a piece. I would have used a piece, if I had had it.

Q. But having used a powder, which was all you had, you did not mix it?

A. No, I did not mix it. I explained to you that I understand the function of carbon to be a protective layer, to prevent air from getting to the mass of cuprous chloride.

Q. And that is what Adams does not say?

A. Adams does not say one way or the other.

Q. Doesn't he say it has a catalytic function?

A. Either you say he knew what he was talking about or he did not know what he was talking about.

Q. Which did you decide?

A. Which did I decide?

Q. Yes, sir.

A. I have not quite decided yet.

Q. Thank you.

[fol. 531] A. I think he knew exactly the term he used, and I attributed it to technical terminology.

Q. It is a highly technical matter which is covered in the patent?

A. It is a highly technical subject.

Q. This small sample which you used in the narrower form was about one and a quarter inches or one and a half inches?

A. Something like that, yes.

Q. And you cut off the bottom because you wanted to get rid of the round portion?

A. Yes, sir.

Q. Why did you cut off the top?

A. To smooth it out because it was rough and after the thermometer, the carbon layer was there.

Q. Did you put the thermometer in first or the carbon in first?

A. I don't recall—no, I put the carbon in first.

Q. Then you put the thermometer down through it?

A. Yes, sir.

Q. Don't you think that might have mixed it?

A. Probably.

Q. Were you following the teachings of the Adams patent then?

[fol. 532] A. Certainly.

Q. To mix it?

A. I put the layer on top. It would have mixed the top surface.

Q. So did you cut off the carbon layer?

A. As I told you before, I understood from reading the patent that the function of the carbon was to protect the cuprous chloride from the air.

Q. Where does it say that?

A. It does not say here what the function of it is.

Q. I beg your pardon, doesn't it say what the function of the carbon is? Refer, please, to column 2, line 16, and read me what it says from line 16 to line 21.

A. (Reading) "The wood carbon constitutes a catalytic agent which renders the electronegative electrode 26 successful for the purpose intended, the exact chemical action being unknown to me."

Q. Are you familiar with the construction of these batteries which have been introduced as batteries procured by the Defendant in this case?

A. Yes, sir, except I have never seen one like the silver chloride battery.

Q. You are in the Water-Activated Battery Section at Fort Monmouth, are you not?

[fol. 533] A. Yes, sir.

Q. That is a pretty rare bird?

A. Which?

Q. The silver chloride battery.

A. Yes, sir.

Mr. Arseneau: That is a Navy battery, may I interpose.

By Mr. Reilly:

Q. Does the Signal Corps itself have any silver chloride batteries?

A. Not that I recall.

Q. None?

A. I said, "Not that I recall." I have never seen a silver chloride battery there. I can't recall seeing a bat-

tery which I could say specifically was a Signal Corps silver chloride battery.

Q. Do you know of any batteries here which do not have carbon?

A. I don't believe the Eagle-Picher has carbon in it, although I am not positive. If so, it is very little, at least from the color of the plates.

Q. The rest of them do?

A. The Ray-O-Vac 253 battery does not appear to have carbon in it.

Q. How can you tell?

[fol. 534] A. I am talking from a visual examination, and some of the plates are quite black, and I assume there is carbon in there.

Q. You are looking at them and you don't know from your work at Fort Monmouth what the exact chemical composition of these cells is?

A. No.

Q. How do you know they are cuprous chloride?

A. How do I know they are cuprous chloride?

Q. Yes.

A. Because it is so specified.

Q. And because it is written on the box?

A. I do not think it is.

Q. It is not?

A. Not on the batteries themselves.

Q. Tell me, is there not a 259 battery which is also a silver chloride battery?

A. I don't know.

Q. You don't know?

A. No, sir.

Q. Have you ever made an analysis of the cells in these batteries where you removed the samples?

A. No. There was undoubtedly a lot of work that I could have done on it, but I didn't have an opportunity to work [fol. 535] on them.

Q. Speaking of time, you were only down here for five days, is that correct?

A. That is correct.

Q. You have been given orders to come down here for five days?

A. Approximately five days.

Q. Were those orders oral or in writing?
A. I have travel orders here.

Mr. Wohlfert: I do not think that has anything to do with this matter. I do not think whether he has orders to be here five days or ten days is material to the issues being presented.

Mr. Reilly: Your Honor, I was not asking the question for that purpose. We had a discussion before concerning other matters, and you will recall counsel for Defendant questioned Doctor Mantell concerning his familiarity with the Stokes machine, which was a question directed to a subject which was not directly connected to the subject before the witness, and this is some similar type of question.

The Witness: May I see the orders, please? (Examining orders) Yes, sir, it says approximately six days, because I left on what date?

[fol. 536] By Mr. Reilly:

Q. (Examining orders) Six days. Thank you. Do you want to see it, Your Honor?

Commissioner Lane: No, sir.

By Mr. Reilly:

Q. In this test tube we have two components, cuprous chloride and carbon, is that correct?
A. Yes, sir.
Q. What is the specific gravity of carbon?
A. I don't recall. It is rather light, and it would depend upon the degree of fineness which is present or the degree of dispersity.
Q. The density of carbon in its solid form is ordinarily what? Would you like to look at Hackh's Chemical Dictionary? We have Mr. Brown's copy around someplace.
A. All right. (Examining book)
Q. What is the density of cuprous chloride, before I give you the book?
A. The density of cuprous chloride?
Q. Yes, sir.
A. Oh, that also depends upon fineness. Are you talking about absolute density?

Q. Choose your term, and let me have an answer.
A. Absolute density——

[fol. 537] Mr. Arseneau: That is like asking the witness about the decimal value of a trigometric function.
Mr. Reilly: I will let him see the book. (Handing book to witness)
The Witness: Cuprous chloride is about 3.53.

By Mr. Reilly:

Q. Do you want to look at carbon in this book?
A. As I say, it would depend on the form of the carbon, and the density of a diamond would be different from graphite, and would be different from powdered carbon.
Q. Let us talk in terms of absolute density, and let us have the highest figure you find.
A. I don't see any density listed here.
Q. It is somewhere between 1.5 and 2.3 for carbon?
A. I don't know, but possibly.
Q. Keep looking until you find it. Do you know the density of carbon in a carbon electrode?
A. No, I do not.
Q. Tell me this: Do you know whether the density of carbon is greater or less than the density of cuprous chloride? It is pretty light stuff, is it not?
A. As I say, it depends upon the state it is in.
Q. How about diamonds?
A. Let us look at diamonds.
[fol. 538] Q. Are diamonds the densest type?
A. I would imagine that diamonds are the densest.

Mr. Arseneau: Your Honor, this witness is being asked to guess, and we object strenuously to this line of questioning.
Commissioner Lane: You may proceed.
The Witness: The density of diamonds is identical with that of cuprous chloride.

By Mr. Reilly:

Q. Really? What is it?
A. 3.53.
Q. We have in this test tube which you have described on page 1 cuprous chloride and carbon?

A. Yes, sir.

Q. Will you tell me what absolute density means?

A. What absolute density means?

Q. Yes.

A. Absolute density would probably refer to the density of single crystals in the pure state. Density is weight per unit of volume.

Q. Is that without voids?

A. Yes, sir, without voids.

Q. Solid material?

A. Solid material.

Q. Weight per unit of volume?

[fol. 539] A. Yes, sir.

Q. Have you finished with the book?

A. Yes, if you have no more questions about it.

Q. When you melted this material, the cuprous chloride, with the 3.53 density—is that the right word?

A. Yes, sir.

Q. And carbon with the 3.3 or less density, how did you come out wtih your final density, Mr. Knapp, of 4.00?

A. This I attributed to oxidation of the cuprous chloride unheated. If you heat this material in the test tube, as Doctor Mantell or some previous witness said, it turns black, and pure cuprous chloride does not have a black color, or a dark brown or black color, which is what shows as you heat cuprous chloride, even if you don't use carbon. This I attributed to the oxidation of the cuprous chloride into perhaps cupric oxide, and cupric oxide, if you will look up in the book you will find it has a density of 6.54, and you have a density there of 4.00 for pure cuprous chloride, but as a result of heating cuprous chloride you have formed something of a higher density material, such as cupric oxide, so that you get a slightly higher density than you would with pure cuprous chloride.

Q. With a one-half inch layer of carbon on top of that?

A. I think it is one-quarter of an inch.

[fol. 540] Q. With a one-quarter of an inch layer of carbon, and that would in no way interfere with the oxidation process?

A. It would in no way interefere with it?

Q. Yes, sir.

A. It would interefere to this extent, that it would prob-

ably react with oxygen coming into the test tube, but it would not react with the oxygen occluded from the powder in the test tube.

Q. But you had dried it in a vacuum?

A. I don't recall that that has to do with occluding air.

Q. He does not protect it when moving it from the drier and the evaporator into the test tube?

A. You take the moisture out of the air.

Q. Why did you put it into a vacuum?

A. To eliminate water more rapidly.

Q. And not to eliminate anything else?

A. Not necessarily. I just wanted to eliminate the water.

Q. Suspecting that this reaction took place, and looking for a distinction between Adams and some other things, you of course made an analysis of this sample to determine whether it was cuprous chloride?

A. No, I did not.

[fol. 541] Q. So that your answer that it was cuprous chloride was conjecture or speculation?

A. I used conjecture.

Q. Is that what it was?

A. This is based on a scientific opinion.

Q. On your own opinion?

A. Right.

Q. Let us take this sample, Defendant's Exhibit No. 31. Will you take the top off of that battery, please?

A. Yes, sir. (Witness complies)

Q. Are there any magnesium anodes in there?

A. Now I will need tools.

Q. Have you not already taken out some plates?

A. Yes, sir, the plates which I removed appear to be magnesium anodes.

Q. Do you mean the ones next to the cuprous chloride ones which you have already produced?

A. Yes, sir.

Q. And the other plates were cuprous chloride?

A. That is right.

Q. Do you know if they had carbon in them or not?

A. In this particular battery I believe they had carbon in them.

Q. Do the electrodes, or any of them, run to external [fol. 542] terminals?

A. Yes.

Q. Each of them?

A. Not each of them. Each of them in operation would run that way.

Q. I'm sorry.

A. There is a termination of the cathode and anode on the outside.

Q. At a terminal?

A. Yes, sir.

Q. Is there any mechanism in these batteries at all to hold moisture?

A. There is a mechanism to hold moisture.

Q. What is it?

A. Cotton wevril material.

Q. Where is that cotton wevril material?

A. Between the plates.

Q. Between what?

A. Between the anode and the cathode.

Q. And is the cathode up against the wevril material?

A. Yes, sir.

Q. Does the cathode contact the water?

A. Yes, sir.

Q. Because it has to?

[fol. 543] A. Because it has to in order to get some reaction.

Q. Does the anode do the same thing?

A. Yes, sir.

Q. On the other side?

A. On the other side.

Q. Do you know how these cathodes are manufactured, that is, the process involved?

A. No, I do not.

Q. You have never been in this plant?

A. No, I have never been in the Burgess plant.

Q. Have you ever been in any of the battery plants we have samples of?

A. Yes, I have been in the Eagle-Picher plant.

Q. Do you know how the cathodes in the Eagle-Picher plant are made?

A. I know in general how they are made, but I don't recall the exact steps in the process.

Q. Give as much as you can.

A. The cuprous chloride is mixed with a polystyrene solution, and this I did not check, whether it was a polystyrene solution, and the material pushed through a hopper onto a screen.

Q. It is dried in the hopper?

A. No, it is slurry in the hopper, and the slurry passes [fol. 544] through the hopper onto the screen, where it is leveled off in some manner which I don't recall exactly, and then it is allowed to dry, and the screen is then cut off into the proper size plates.

Q. Does the screen pass underneath the hopper?

A. Yes, sir.

Q. And the material in the hopper is what?

A. It is pushed down. I did not see it but it goes through the bottom of the hopper and is pulled out onto the screen in some other way, and it is pasted and leveled off.

Q. It is shaped something like that?

A. It is a leveling.

Q. How is it leveled?

A. I do not know how it is leveled but it is leveled.

Q. And after that it is permitted to dry?

A. Yes, sir.

Mr. Arseneau: Your Honor——

Mr. Reilly: Do you have any objection?

Mr. Arseneau: Yes, I object. I think we are getting outside the scope of the direct examination. So far as the field of battery construction is concerned, that is one thing, but so far as having our witness testify on contractor techniques, it is an attempt to elicit——

The Witness: As I said——

[fol. 545] Mr. Arseneau: Excuse me. It is an attempt to elicit from our witness testimony which is a part of the Plaintiff's prima facie case, and I think it is outside the scope of the direct.

Mr. Reilly: You put this witness on to testify concerning a composition of these plates, and I am asking him what goes into these plates, and how they are made.

Mr. Arseneau: I did not put him on to prove contractors' techniques.

Mr. Reilly: I do not know about your purpose, Mr. Arseneau, but I am talking about the subject matter.

Mr. Arseneau: The direct did not relate to his knowledge of events taking place in the Eagle-Picher plant. I would like to have the Court rule, if you don't mind.

Mr. Reilly: I will await the ruling.

Commissioner Lane: I will overrule the objectin.

Mr. Reilly: Thank your, Your Honor.

By Mr. Reilly:

Q. The screen goes underneath the middle of it?

A. The screen in the Eagle-Picher one is in the middle.

Q. What is the difference in other cases?

A. I do not know.

Q. And are they mixed up in that cuprous chloride carbon mix?

A. By the use of carbon?

[fol. 546] Q. Didn't you say that?

A. No, I did not.

Q. In the cuprous chloride there was some absorbent cotton or fibrous material, was there not?

A. There was some cotton material there, yes.

Q. Would that absorb water?

A. Do you mean in this test?

Q. Not this test but if there are cotton linters in a mix like that, could the linters absorb water?

A. I would imagine so.

Q. Supposing in one of these battery types you had a cuprous chloride powder dried on a cotton wevril or a fabric screen, would that absorb water?

A. I would imagine so.

Q. But you do not know how the Burgess battery is made?

A. No, sir.

Q. Was one of the batteries you tested the Burgess battery?

A. Yes.

Q. Which one- You did take some cathodes out of that, did you not?

A. Yes, sir.

Q. Would you look at one of those cathodes, please?

[fol. 547] A. (Examining) Yes, sir.

Q. What seems ot be the material?

A. It seems to be a fiber.

Q. Thank you. The exhibit number is 31-D. At what page do you talk about 31-D?

A. You mean in my notebook?

Q. Yes, sir. What did you find was the increase in weight on that sample?

A. .12 grams. Do you mean the sample?

Q. Yes, sir, and for all of them?

A. .12 to .14 grams.

Q. Let us take the Usalite Battery, the BA 253/U. What is the weight of water absorption of the cathode on that battery?

A. .427 grams.

Q. Do you know the type of material used in the Usalite battery?

A. No, sir, I don't.

Q. Do we have a sample?

A. Not here.

Q. We have no samples here to illustrate the type of plate you took out of that battery?

A. The 253 would be a Ray-O-Vac one.

Q. What happened to the sample of this battery re-
[fol. 548] ported on ; ze 4?

A. I don't know.

Q. You were testifying before concerning, I believe, a storage battery.

A. Yes, sir.

Q. I believe you stated that when you were calculating the figures on increase in weight and water absorption, if an error was made, it would be on the low side, and actually the water absorption would be greater than the figures shown.

A. Yes, sir.

Mr. Arseneau: Objection. He testified as to porosity.

The Witness: Will you repeat the question? I may have misunderstood it.

Mr. Reilly: Read the question, please, Mr. Reporter.

(Question read.)

The Witness: The water absorption and the porosity would be greater than shown.

By Mr. Reilly:

Q. Is that also true for Defendant's Exhibit No. 35?

A. Yes, sir.

Q. May I ask when you obtained the batteries which you used for testing?

A. The batteries which I used for testing were in my laboratory at Fort Monmouth, and they had been there for [fol. 549] some time.

Q. How many do you have there?

A. Roughly I have one more I think in a sealed can, but I am not sure how many I have of the others.

Q. If you need more, what do you do?

A. If I need more, I order them through Procurement, or try to find somebody who has one around the area.

Q. Do you have any storeroom at Fort Monmouth which has one?

A. No, no water-activated batteries. They have the ordinary type battery in stock.

Q. How big is your laboratory?

A. I have two rooms, one-half of one and the entire other room. I would say one-half of one would be about as big as this area.

Q. How many assistants do you have?

A. I have two assistants.

Q. How many batteries of this type do you have in the laboratory, among you and your assistants?

A. Of these types?

Q. Yes, sir.

A. As I say, I have one battery like this, and I probably have two or three of the Eagle-Picher battery, the 259 battery, and I have some more recently developed, and [fol. 550] I was interested in maybe 15 or 20 of them which were recently developed.

Q. 15 or 20 of the Eagle-Picher battery?

A. Not this kind.

Q. A different kind?

A. Yes, sir.

Q. How many of the Eagle-Picher 253 do you have around?

A. Two, three or four or in that area, but I am not sure how many I have. They would be in the storage area

because we do not use them very often, but it is certainly not more than five at the most.

Q. Did anybody in the last couple of months or so ask you for any batteries?

A. No.

Q. You performed a toluene test on certain types of cells?

A. Yes, sir.

Q. And they fell apart?

A. Yes.

Q. Did you perform a toluene test on this? (Indicating)

A. No, I did not.

Q. What does making a toluene test consist of?

A. Making a toluene test would just improve the porosity of the plate.

[fol. 551] Q. Did you try it on this one?

A. I did not, but I tried the water test on this.

Commissioner Lane: By "this," you are referring to what?

Mr. Reilly: By "this," I am referring to Defendant's Exhibit No. 35.

The Witness: I tried it with water.

By Mr. Reilly:

Q. Yes, I know you did try it with water, because you have that in your notes. Did you try any other test besides the water test on this sample, Defendant's Exhibit No. 35?

A. Did I try any other test on that sample besides the water test?

Q. Yes.

A. No, no test, but I made density measurements.

Q. Did you make density measurements on any of the other five test tubes of cuprous chloride which you liquefied by heat-

A. No, sir.

Q. Did you ever pick them up and feel them with your hands?

A. Yes. I made a density test on one of them, or a piece of one, Sample No. 13.

Q. Page 13?

A. No, Sample No. 13.

[fol. 552] Mr. Arseneau: Page 5 in the book.

The Witness: No, I did not calculate the density, but it could be calculated.

By Mr. Reilly:

Q. You only calculated the density of this one sample?

A. That is all. As I said, I was a little rushed for time on this, and instead of using a lathe I used a hacksaw, and it was from .100 to .130 inches thick.

Q. Did not a ten-day period elapse between the time you made your initial melted-by-heat sample and the time you gave?

A. I would have to look up to find out (examining). In fact there were twelve days.

Q. Twelve days?

A. Yes, sir, eleven or twelve.

Q. How much was left of that test tube sample on Defendant's Exhibit No, 35, which you sawed off?

A. I don't recall. I started with a top and bottom piece.

Mr. Arseneau: Excuse me but the testimony is it was in a lathe or machine tool and not sawed off.

The Witness: That is right.

By Mr. Reilly:

Q. Give me your best estimate of the density of the upper end of the material you have in Defendant's Exhibit [fol. 553] No. 35, and would it be more or less?

A. On the upper end?

Q. Yes, sir.

A. I think, as you get into the zone of carbon, you get less density. As I say, the carbon on this sample was fused on a little more, if you want an opinion as to how that was done.

Q. When you faced this in a lathe, you put a sharp edge against the surface and cut through?

A. Yes, sir.

Q. And the other piece?

A. No.

Q. Do you mean you ground off all the piece except this?

A. The sharp tool cuts through across the surface.

Q. Like a knife?

A. No, the material is thin.

Q. I know the material is thin.

A. And you do not have pieces.

Q. Do you mean you used a chisel to chip and cut it all the way but this?

A. The material is rotated in a lathe, and as the material is pushed against the knife, the material is spinning and rotating, and it cuts against the blade.

[fol. 554] Q. What kind of lathe are you talking about?

A. A machine lathe.

Q. Do you chuck it between two points?

A. You chuck it at one point.

Q. You chuck it at one point?

A. Yes, sir.

Q. And when you cut or get the sample out, you remove the dust from all the remainder except this?

A. Yes, sir.

Q. At the end of this process, what happens? Does it fly off the lathe?

A. No, that is held by the chuck. Your bit comes forward, and only on the face surface, so that when you are finished facing it off, the remaining part is in the chuck, and the rest from the face-off point back is dust.

Q. So you do it twice?

A. Yes.

Q. If you had mixed in this carbon throughout this mixture, while heating it——

A. Did you say if I had?

Q. If you had.

A. All right.

Q. (Continuing)—do you think the density would have been different than the density reached in this sample?

[fol. 555] A. If you have a density of 3.3 carbon, and they were both the same density, there would probably be no difference in density, if they were both the same.

Q. Give us your opinion.

A. That is what you told me was found for carbon.

Q. Use whatever figures you want.

A. If I compared it with this material, I would expect it would be lighter than this.

Q. Would you expect it to be more porous than this material, Defendant's Exhibit No. 35?

A. It would depend upon the type of carbon I used.

Q. I am talking about the type of carbon which you did use.

A. I did not mix the cuprous chloride, and I could not tell you, as I said before.

Q. I want your opinion as to what would have happened if you stirred in the type of carbon which you used.

A. I think it would probably have been more porous.

Q. Supposing you had used activated carbon instead of the kind of carbon you did use, what would be your opinion as to the porosity of the sample?

A. I do not think it would have—I am not sure for this reason: If the activated carbon were much finer than this carbon, it probably would have less porosity.

[fol. 556] Q. In other words, it is just a matter of the particle size, as you view it?

A. Yes, sir.

Q. And you do not feel——

A. The particle size and the dispersion. In other words, it would possibly be more porous, if you had carbon of different size, and then it would be different from what it would be if you had a single size. As I say, you have to pick your carbon.

Q. You do?

A. Oh, yes.

Q. As a battery expert, I ask you, could you make this sample porous by using carbon? Could you do it?

A. That particular sample?

Q. Or a sample made like this one.

A. Do you mean, could I have added carbon to a cuprous chloride mix and heated it, melted it, and get a more porous structure than that? Is that what you are asking?

Q. Yes.

A. Yes, sir.

Q. And the degree of porosity would vary?

A. Yes, sir.

Mr. Reilly: May I have a few minutes, Your Honor?

Commissioner Lane: Yes, sir.

[fol. 557] (Discussion off the record.)

Commissioner Lane: You may proceed.

Mr. Reilly: Just one or two more questions, Your Honor.

By Mr. Reilly:

Q. How much oxygen would be entrained in the powder, the 15 grams of powder that you put into the test tube?

A. I do not know. I did not measure it.

Q. Could you give me the weight in a volume of 15 grams of cuprous chloride? Let us say it was three inches high by one-half inch wide.

A. If you want a calculation of it about three inches by one-half inch wide, I could get that, and if I had a piece of paper and pencil, I would calculate it out.

Commissioner Lane: Defendant's Exhibit No. 35 measures 11/16ths or over one-half inch in diameter.

By Mr. Reilly:

Q. Have you got it approximately? You do not have to have it to the last decimal. If you have it to the nearest cubic centimeter, it would be fine.

Mr. Arseneau: What is the question, please, Mr. Reporter?

(Question read.)

Mr. Reilly: I will put another question.

By Mr. Reilly:

Q. I have asked you, Mr. Knapp, to calculate the volume [fol. 558] of the oxygen in the test tube, assuming that all the cuprous chloride, the level of all the cuprous chloride was 100 per cent oxygen and no cuprous chloride, and what would we have?

A. That is something I did not understand before.

Q. What were you calculating?

A. I was calculating the void space that would result from the difference between the density of the cuprous chloride and absolute density of cuprous chloride.

Q. In other words, you were calculating the possible volume of entrained air? Is that it?

A. Approximately I would say that the volume of heating probably drops by almost one-half.

Q. I want the figure.

A. What figure?

Q. Of the volume you worked.
A. I did not work it. I did not complete it.
Q. I'm sorry, go ahead.
A. You interrupted me.
Q. Did I interrupt you?
A. Something interrupted me.

Mr. Arseneau: The witness was being asked to calculate something, and I want to know if he is sure.
The Witness: It was not what he asked.

[fol. 559] By Mr. Reilly:

Q. It was some time ago that I asked the question.
A. Yes, it was.
Q. Go ahead and tell us what you have got because we have invested enough time.
A. You are the one who requested the calculation. Approximately 2 c.c. of air would be entrained.
Q. In the 15 grams there would be approximately 2 c.c.'s of air?
A. Possibly 2 c.c.'s of oxygen.
Q. How much cuprous chloride would be converted to cupric oxide by that amount of oxygen, Mr. Knapp?
A. It would take time to calculate it.

Mr. Arseneau: Let's go to lunch.
Mr. Reilly: It is all right with me.

(Discussion off the record.)

Commissioner Lane: Will 1:30 be all right?
Mr. Reilly: Yes, sir.
Mr. Arseneau: I have to go back to the hotel, but we will do the best we can.
Commissioner Lane: We will recess then until 1:45.
Mr. Arseneau: Thank you, Your Honor.

(Whereupon, at 12:30 o'clock p.m., a recess was taken until 1:45 o'clock p.m.)

[fol. 560] AFTERNOON SESSION

(1:45 o'clock p.m.)

Commissioner Lane: You may proceed.
Mr. Reilly: Thank you, Your Honor.

Whereupon HOWARD RAYMOND KNAPP, the witness on the stand at the taking of the recess, resumed the stand and testified further on behalf of the Defendant, as follows:

Cross-examination (Resumed)

By Mr. Reilly:

Q. I believe when we had closed before lunch, sir, that you had calculated that you would have 2 c.c.'s of entrapped oxygen.

A. 2 c.c.'s of entrapped oxygen.

Q. In the cuprous chloride?

A. That is right.

Q. In the test tube?

A. Yes, sir.

Q. How much cuprous chloride would be converted to cupric oxide by 2 c.c.'s of oxygen?

A. The answer I have does not include any oxygen which could be absorbed by the contents, and most of these contain that as well as entrapped, by I calculated approximately .01 grams of cupric oxide would be formed.

Q. If you had this amount of cupric oxide, as calculated by you, in 15 grams of cuprous oxide, what would be the [fol. 561] density of the mixture?

A. I have no idea.

Q. Would you also agree with me that it would be 3.536 grams.

A. I wouldn't know.

Q. Please calculate it.

A. It is rather impossible at the moment.

Q. What is impossible about it? You talked about .01.

A. I will accept that, and if that is the only oxygen present, the 2 c.c.'s, I would accept that figure and I would say it is not impossible to calculate it.

Q. Would you agree with this statement of mine:

The stability of the cuprous state over the cupric state is increased at high temperature?

A. At how high temperature?

Q. 433 degrees Centigrade.

A. If I may answer this way, cupric chloride on heating to extremely high temperature will convert to cuprous.

Q. Do you have any drawings of these battery types or cells in your laboratory?

A. There may be some in the contractors' reports, but I would not know of any specific place where the drawings of one of these batteries would be.

Q. You recall seeing some of them in the contractors' [fol. 562] reports?

A. It may be possible. I have seen copies of blueprints, but I am not sure I saw it in the contractors' reports or where.

Q. But you have seen them for these drawings?

A. Yes, sir.

Q. If someone asked you to make drawings of these batteries or of a typical cell and label the components, could you do that?

A. Yes, sir.

Q. Has anybody asked you to do that in the last couple of months?

A. No.

Q. Just me?

A. Just you?

Q. I am the first one who asked you? Is that true?

A. Yes, sir.

Mr. Reilly: Thank you very much, sir. I'm sorry I could not finish with you before lunch, and I say that sincerely.

Commissioner Lane: Any redirect examination?

OFFER IN EVIDENCE

Mr. Arseneau: Yes, Your Honor. Your Honor, before I commence my redirect examination of Mr. Knapp, I notice that Defendant's Exhibit No. 37 for identification, [fol. 563] which is this 1940 report, was not formally moved into evidence, and I now request that that be done.

Commissioner Lane: Any objection?

Mr. Reilly: I have no objection to this being introduced.

Commissioner Lane: Defendant's Exhibit No. 37 will be received in evidence.

(The document heretofore marked for identification Defendant's Exhibit No. 37 was received in evidence.)

Redirect examination.

By Mr. Arseneau:

Q. Mr. Knapp, I would like to direct your attention to the Adams Patent No. 2,322,210, which has been offered as Trial Exhibit No. 10.

A. Yes, sir.

Q. I would like to ask you whether that patent has any teaching or any mention of the starting amount of cuprous chloride?

A. No, it does not. I would like to look at it for a moment, however.

Q. Mr. Knapp, during your cross-examination by Mr. Reilly I believe you mentioned that the samples of cuprous chloride electrodes, or rather just the cuprous chloride samples, had been constructed by you, other than the ones which are in the book, and I would like to ask you this: [fol. 564] Have you ever met Robert F. Frankel?

A. Yes, I have.

Q. During Mr. Frankel's visit to your laboratory, did you ever construct any samples of cuprous chloride, by melting in a test tube and allowing it to set?

A. Yes, I have.

Q. What did you do with those samples?

A. I believe they were discarded.

Q. I understand. I wonder if you would turn to this: During my visit to Fort Monmouth, do you recall making any samples by melting cuprous chloride in a test tube?

A. Yes, sir.

Q. By the archaic means of applying heat?

A. Yes, I did.

Q. Thank you very much. What did you do with the samples made during my visit?

A. I think they were discarded. No, I don't know where they are now, so I assume they were thrown out. These samples were made during the visit of Mr. Arseneau and Mr. Frankel, to see what a sample melted by heating cuprous chloride looked like.

Q. That verbal explanation is appreciated, Mr. Knapp. I will ask you in connection with destroying or discarding these samples which were made, will you tell the Court

[fol. 565] whether it was before or after the time when you started to keep this notebook?

A. This was before.

Q. Mr. Knapp, do you feel if you had poured this cuprous chloride into another container, that the results which you testified to in connection with your notebook would have been significantly different?

A. No, they would not have been significantly different, in my opinion.

Q. Now the question I would like to ask you, if I can keep on continuing to borrow a copy of Trial Exhibit No. 10, is this:

Will you tell us in reference to lines 5 through 20 of Mr. Adams patent, first of all if the word "carbon" is referred to?

A. Do you mean in column 2

Q. Yes.

A. The carbon is referred to as a piece of wood carbon.

Q. What does the Adams patent mention with respect to this wood carbon?

A. It is placed on top of a cuprous chloride in the crucible.

Q. Mr. Knapp, can a piece of wood carbon placed on top of molten cuprous chloride give rise to porosity through-[fol. 566] out the material?

A. Very little, if any. I would say no.

Q. Mr. Knapp, in Trial Exhibit No. 10, will you please give us the column and line reference of any mention of the use of powdered, granular or pulverized?

Mr. Reilly: I will stipulate that there is none.

Mr. Arseneau: There is a stipulation that there is no such reference.

By Mr. Arseneau:

Q. Mr. Knapp, I would like to ask you this question:

When cuprous chloride is heated up to the molten condition and subsequently allowed to cool down, can you tell me in your opinion whether carbon brought into contact during that interval with the cuprous chloride acts as a catalyst?

A. I wouldn't so judge it to be a catalyst.

Q. Mr. Knapp, this morning there was testimony, both on direct and cross, with respect to Defendant's Exhibit No. 35, which I believe is a disc-shaped sample of cuprous chloride, and I will go a step further, and with counsel's permission I will say that it is the one referred to where it was faced on a lathe in the machine shop.

A. Yes, sir, this is it here (indicating).

Q. Would you explain to the Court why it was necessary to have the machinist face that sample that way?

[fol. 567] A. Yes. The sample took the shape of the test tube, and I wanted to get exact measurements for the testing, and I had a right cylinder, which was the most convenient shape, and I wanted the bottom to be faced off to be parallel or have parallel edges of a cylinder.

Q. Is there any change in the carbon after machining?

A. Definitely, there was.

Q. During the melting, how did you gauge the temperature?

A. With a thermometer.

Q. Did the placement of the thermometer within the test tube give rise to an irregularity which you wanted to eliminate?

A. Yes, the test tube, in order to get an accurate measurement of the temperature in the mix, the thermometer was inserted into the top layer of the carbon, the layer on top and the surface of the cuprous chloride.

Q. Mr. Knapp, referring generally to Defendant's Exhibit No. 30, which is your notebook, in which you kept the results of your testing—I am only referring back to the book—and the various samples referred to therein, when you extracted certain plates from certain of these batteries, did you strip all the cotton or fabric material off of those plates?

A. Yes. May I say that I stripped off all the material [fol. 568] that was at the surface of the plates?

A. I understand.

Q. Mr. Knapp, do you recall before the luncheon recess that Mr. Reilly placed before you, I believe, Defendant's Exhibit No. 31, which is a battery from Burgess, as printed on the side of the box?

A. Yes, sir.

Q. And I believe you were also asked to inspect one of the samples?

A. Yes, sir.

Q. And reference was made to a gauze or fiber grid. I would like to place before you Defendant's Exhibit No. 32, which has "Eagle-Picher" imprinted on the side of the box, and I would also like to place before you Defendant's Exhibit No. 32-B, and ask you if you will inspect it and after you inspect it, will you tell us what the greenish material thereon is applied to?

A. It appears to be a copper grid.

Q. I would like to ask you this question: Does a copper grid have any water absorbency?

A. No.

Q. Thank you very much. You may recall the type of grid that was in some of the other batteries which you tested and marked up.

[fol. 569] A. Several of them contained a metallic grid, and the sample of the Burgess battery appeared to be a fiber material grid.

Q. Mr. Knapp, do you have a copy before you of the Adams patent, Trial Exhibit No. 10?

A. Yes, sir.

Q. I may have asked you this question before, but I will ask you again: Can you show us in the text of this patent specification where it teaches the uniform distribution throughout the cuprous chloride of carbon granules and carbon particles? I refer you to the first mention of carbon in lines 5 through 20 in column 2.

A. I have read this several times but I do not recall at the moment. I can find no place where it mentions that it is dispersed, throughout the cuprous chloride.

Q. Do you find any reference there to activated charcoal or activated carbon therein?

A. No.

Q. Mr. Knapp, just prior to the luncheon recess, and shortly thereafter, there was some testimony here on the value of oxygen entrained or entrapped in a certain quantity of cuprous chloride. As I understand it, you came up with a value of 2 c.c. Does that calculation represent the entrained oxygen, entrapped in the voids or interstitial [fol. 570] spaces in cuprous chloride?

A. That would include the voids between particles of copper chloride.

Q. I understand. You mentioned the value of 2 c.c.?

A. That is the approximate value.

Q. I am a little disturbed about this, and I will put the question to you. Would a portion of cuprous chloride poured into a beaker or test tube or container always have the same compaction with the same degree of density?

A. Definitely not. You can get more cuprous chloride, depending on how you treat the material.

Q. Let us go one step further. Some reference was made to conversion to cupric chloride, I believe.

A. I mentioned that it goes to that, and probably what was said was there is some conversion to cupric oxide.

Q. I stand corrected, sir. I forgot the word or else I could not read my own handwriting.

Let me restate the question:

Some reference was made to cupric chloride in .01 grams in that connection, was there not?

A. No, sir. The .01 grams was the amount of cupric oxide to be formed from 2 c.c.'s of oxygen.

Q. Cupric oxide?

A. Yes, sir.

[fol. 571] Q. I would like to ask you this: When you calculated that value of cupric oxide, did you use 2 c.c.'s of entrapped oxygen?

A. Yes, sir.

Q. Did you mention the phenomenon of heating cuprous chloride?

A. Yes, sir.

Q. How high would it go?

A. I don't know.

Mr. Arseneau: Your Honor, I would like to ask for a five-minute recess here.

Commissioner Lane: Five-minute recess.

(Short recess.)

Mr. Arseneau: Your Honor, I believe that terminates our redirect of Mr. Knapp.

Commissioner Lane: Will there be any recross?

Mr. Reilly: No, Your Honor.

Commissioner Lane: You are excused, Mr. Knapp. Thank you very much for your testimony.

The Witness: Thank you, Your Honor.

(Witness excused.)

Commissioner Lane: Next witness.

Mr. Arseneau: I will ask the Court's indulgence for a few minutes to get organized.

[fol. 572] Commissioner Lane: Very well.

(Pause in the proceedings)

Mr. Arseneau: Your Honor, at this point I will ask that Doctor White take the stand and be sworn.

Whereupon Joseph C. White, a witness produced on behalf of the Defendant, being first duly sworn by said Commissioner, was examined and testified as follows:

Direct examination.

Mr. Arseneau: Your Honor, in order to expedite the application of the prior art, we have taken the prior art patents which we intend to rely on, and have made them up into two looseleaf books, and we have included in the index of the patents in the two books these documents, and they are listed as Defendant's exhibits, and one of these books is captioned "Court," and I will give it to the reporter for his convenience, and also there is the index of various patents.

I also have a duplicate set of these books which I have captioned "Commissioner," and if Your Honor desires to have copies of the art before him, these books are the same as the others that I have given to the reporter in every respect.

Commissioner Lane: Thank you.

Mr. Arseneau: I think it might be more convenient and [fol. 573] save Mr. Reilly trouble, since there is an index of the art keyed in with the exhibit numbers.

Mr. Reilly: Thank you, sir.

Mr. Arseneau: One other thing which I think should be

alluded to perhaps before starting the examination of Doctor White.

Reference was made yesterday to Defendant's Exhibit No. 2, which was Hackh's Chemical Dictionary. Is there any objection to giving it a different number? I would suggest, if there is no objection, that it be called Defendant's Exhibit No. 40.

Commissioner Lane: The number "Defendant's Exhibit No. 2," will be changed to read "Defendant's Exhibit No. 40."

(Excerpts from Hackh's Chemical Dictionary heretofore marked and received as Defendant's Exhibit No. 2 was remarked and received in evidence as Defendant's Exhibit No. 40.)

By Mr. Arseneau:

Q. Would you state your name for the record, please?

A. Joseph C. White.

Q. Will you tell us where you are presently employed and what your position is at that place?

A. At the United States Naval Research Laboratory in Washington, D. C., and of this moment I am responsible for [fol. 574] the Electrochemistry Branch of the Chemistry Division.

Q. Will you tell us what the job title is?

A. Branch Head.

Q. Will you tell us what academic degrees you hold, Doctor?

A. B.S., M.S. and Ph.D.

Q. Will you tell us what your field of specialization was during your graduate studies?

A. Physical electrochemistry.

Q. Can you tell us whether your Bachelor, Master and Doctorate Degrees were received during a continuous period of time, or whether there were periods of employment in between?

A. One summer I worked for a chemical plant, after I graduated from college. Other than that, it was all spent in graduate school as a part-time employee of the University.

Q. Doctor White, will you tell us some of the positions

you have had since you have started in professional practice, and sketch briefly your various types of problems, the problems you dealt with while in these employments?

A. I served twelve years as a Instructor of Physical Chemistry at the University of Maryland, after finishing my degree, and since that time I have had essentially the same job with the Naval Research Laboratory that I now hold.

Q. I understand. Will you tell us some of the types of [fol. 575] projects and types of systems which you have worked on or investigated or been retained on at the Naval Research Laboratories?

A. Will you indicate how brief I should be?

Q. I do not think you have to go into any great detail, Doctor, but in a few words.

A. Primarily, my work has been mostly in the field of electrochemistry, and most of that has been associated with battery research.

One part of this effort has been related to the measurement and control of the atmosphere in submarines. Included in this, particularly in the last 15 years, I have done a considerable portion of more or less basic research involved in the mechanisms of some of our presently used batteries.

That is it in general but I can go into detail.

Q. Doctor, have you had occasion during the period of your employment to investigate cathode materials or anode materials and electrolytes?

A. Yes, sir.

Q. Have you done any work on metallic type batteries, activated by the addition of water electrolytes?

A. A limited amount.

Q. Will you tell us what professional associations you [fol. 576] hold membership in, Doctor?

A. American Chemical Society, the Electrochemical Society, and I am not sure whether Sigma Zi would be such a society, and the Research Society of America, RESA.

Q. Doctor, will you turn to the prior art book now?

A. Yes, sir.

Q. And I wonder if you would turn to this Niaudet literature, reference which we have identified as Defendant's Exhibit No. 1, and I wonder if you would tell us whether

you have had an opportunity to examine this Niaudet article, and, if so, tell us briefly what it teaches you as one skilled in the art?

A. Yes, I have had an opportunity to study this book, which was apparently an attempt on his part to review the types of batteries which were in existence up through about 1870, and he apparently has tried to describe or give the characteristics of the types of cells which were then known.

Q. Doctor, I would like to refer you briefly to page 201 and to the material beneath the caption "Chloride-of-Silver Battery," and I would like to ask you what that teaches one skilled in the battery art?

A. Of course this is more or less of a history book, in which he has indicated from his own literature references that Marie Davy has made with reference to the silver chloride battery.

[fol. 577] Q. What is the other electrode material used?

A. In this particular case he used zinc.

Q. Can you tell me what the electrolyte is?

A. He says pure water but as soon as the current starts to flow it becomes a solution of zinc chloride.

Q. Will you tell us what form the silver chloride is said to appear in?

A. He specifically states that he melted the chloride of silver in a silver crucible.

Q. Doctor, I would like to refer you to page 202 of the same reference, approximately to the middle of the page, and I ask you what the text therein teaches concerning the battery system by Mr. De La Rue? What I am referring to more particularly, if it is of any assistance, is the third paragraph up from the bottom.

A. In this particular cell he apparently melted a cylinder of silver chloride around a silver strip. The purpose of the silver, of course, was as a means of conduction and perhaps also to form a terminal.

Q. Will you tell us what the other electrode was in the De La Rue cell?

A. Zinc.

Q. Can you tell us what the electrolyte was?

A. Ammonium chloride.

[fol. 578] Q. In what form is the silver chloride which is employed in the De La Rue cell?

A. In the ordinary use of the word, I would say it was a fused silver chloride electrode.

Q. Doctor, I would like to direct your attention momentarily to IX in the table of contents of this Niaudet book, and I would also generally like to direct your attention to pages 200 through 209, and I would like you to give us your opinion as to whether a person skilled in the art would consider this text as teaching depolarizers constructed of any metallic chlorides other than silver chloride?

A. Certainly this is an indication that people have tried platinum chloride as well as lead and iron.

Q. I would like to refer you to Trial Exhibit No. 2 which is the Hayes Patent No. 282,634, and I would like to ask you, Doctor White, whether you have had an opportunity to study this Hayes patent?

A. Yes, I have.

Q. Will you state briefly what this patent teaches you as one skilled in the battery field?

A. Very briefly, apparently at the time, which was in 1883, he was trying to improve the so-called chloride of silver batteries which apparently had been well known for [fol. 579] some time.

Q. Directing your attention to Figure 2, would you tell the Court what this configuration means to you generally?

A. In my own opinion, this is a sort of schematic drawing of a conventional type of cell in which he is showing the use of fused silver chloride as one electrode, placed with zinc in some form or other as the other electrode, in a diluted solution of sodium chloride.

Q. I understand.

Mr. Reilly: So that the record will not be confused, I think the witness should explain what he means by "fused."

Mr. Arseneau: I have no objection to that whatsoever.

The Witness: "Fused" in the usual rather specific and necessary technical language of the science certainly means melted.

It would have meant that you would have melted it and let it cool again.

Commissioner La[illegible]: Melted in what way?

The Witness: Heating or by raising the temperature.

By Mr. Arseneau:

Q. Doctor White, for the record, returning to Figure 2 of Hayes, will you tell us what the element B is, what it is comprised of? If you have to use the exact terms of the specification as set forth on page 2, line 9, all right. [fol. 580] It is in the left-hand column, lines 9 through 10, and I have no objection to you using that, but I would like to have you tell us what the "B" designation is in Figure 2.

A. The "B" part of this electrode represents fused silver chloride on a pure silver wire.

Q. I understand. In brief tell us what "C" designates?

A. "C" is a zinc plate.

Q. Doctor, will you repeat again what the material is in "C"?

A. Zinc.

Q. Thank you. Referring your attention to reference numeral "K", and to page 1 of the patent, on page 1, the right-hand side, line 98, can you tell us what the battery fluid "K" consists of?

K indicates that it contains either a two per cent solution of sodium chloride or ammonium chloride in distilled water.

Q. In your opinion, Doctor, what would be the function of the sodium chloride?

A. To render the solution conductive.

Q. Thank you very much. Are sodium chloride and ammonium chloride the only salts which have this effect?

A. No, I would assume that any salt that ionized in solution and did not attack at an appreciable rate with [fol. 581] reference to the system would be suitable.

Q. Doctor, in Figure 2 of the Hayes patent, can you tell us what the reference character "H" designates? I am directing your attention to lines 8 to 10 on page 2, if that is of any assistance.

A. This apparently is a simple method of connecting an outside connection to the zinc electrode by means of a screw.

Q. Doctor, what is "E"?

A. In this particular case apparently he has left an end out of the mold in which he has cast fused silver chloride

in order to provide for a lead from the cell, which could also act as a terminal.

Q. Leaving this patent, Doctor, will you turn over to Defendant's Exhibit No. 3 for identification, which is excerpts from a book by Bottone, entitled "Galvanic Batteries"?

A. Yes, sir.

Q. I would like to ask you if you have had the opportunity to study this material?

A. Yes, I have had some opportunity to study this.

Q. I would like to refer your attention to Section 85 over on page 172, and I would like to ask you briefly what this teaches you as one skilled in the art of electrochemistry?

A. He is describing a cell which apparently De La Rue was primarily responsible for, in its practical form, in [fol. 582] which he used a silver chloride electrode along with a zinc rod, and in which he also used ordinary table salt, sodium chloride, as the electrolyte.

Q. Doctor, referring to these electrodes, and particularly to the text thereon, will you tell us in what form the silver chloride was?

A. Apparently in order to get a proper functioning of the electrode it had to be fused.

Q. Referring to the solution of sodium chloride, can you tell us if sodium chloride is the only salt which would serve in this fashion?

A. No, I believe that any salt which would ionize in solution and would not react appreciably with the electrode would be suitable.

Q. Doctor, I wonder if you would turn over to page 176 in this reference?

A. Yes, sir.

Q. I think that is Section 88. I wonder if you would state briefly your understanding of the Mackenzie cell, described thereat?

A. Mackenzie apparently felt that there was a need for a portable cell.

Mr. Reilly: What is the reference?

Mr. Arseneau: Page 176, referring to Section 88, down [fol. 583] near the bottom of the page.

The Witness: Will you repeat the question, please, Mr. Reporter?

(Question read.)

The Witness: Yes, this was a cell apparently somewhat like the De La Rue cell, in which Mackenzie offered the use of a copper tube which he apparently silvered for better conductivity, and also it would be in contact with a fused silver chloride.

In addition to this, he used a rod or cylinder of zinc as the other electrode, and had terminals connected to the top and bottom.

By Mr. Arseneau:

Q. Now, Doctor, for the record will you flip over to page 177, four lines down from the top, and will you tell what form the silver chloride electrode was?

A. The interior of this copper tube, which had been coated with silver, had been covered with a layer of fused silver chloride.

Q. Doctor, some lines down, say almost to the end of the first full paragraph, will you tell us what the exciting electrolyte solution was in the Mackenzie cell?

A. Apparently he had not specified any particular one, but you could use zinc chloride, zinc sulphate or sodium [fol. 584] chloride.

Q. Please go back to page 176, and will you state what the upper and lowermost threaded objects are in Figure 71 shown there?

A. Those are simply terminals for the convenience of connecting on an external wire.

Q. Thank you, Doctor. I refer you now to Defendant's Exhibit No. 4 for identification, which is entitled "Primary Batteries," and it is a literature reference by Mr. Carhart. Do you have that?

A. Yes, I have it.

Q. I will ask you if you have had an opportunity to study this reference?

A. Yes, I have.

Q. Referring to page 62 of this reference, Section 43, will you tell us briefly what this reference teaches you as one skilled in electrochemistry?

A. This being a textbook, again he is reviewing the history of primary batteries, and he indicates here again that Marie Davy was apparently responsible for the first use of silver chloride in a depolarizer, and this was about 100 years ago.

Q. Continue, please.

A. It was not until after De La Rue, who made a few [fol. 585] modifications o fthis, that it really became practical, and, as indicated therein there were quite a few made, 15,000. In these cells, repeating what I have already said before, he used the zinc and a cast silver chloride rod, metallic silver, for the other electrode, and in this case he did introduce the use of some sort of separator.

Q. Doctor, this is more or less an aside, but in applying the prior art to primary batteries and the instructions by De La Rue, you used the words cast "silver chloride," and in Defendant's Exhibit No. 3 by Bottone, you used the word "fused" to characterize the silver chloride as the depolarizer.

Will you comment on the usage and give us your opinion?

Mr. Reilly: I object, Your Honor. Defendant's counsel is quarreling with his own witness.

Mr. Arseneau: I am not quarreling about the references, but I am asking the witness whether in his opinion the two different technical terms are synonymous or not synonymous. I will take the Court's ruling.

Commissioner Lane: Objection overruled.

The Witness: Yes, this could perhaps be cleared up very easily by saying that before he was able to cast the fused chloride around the grid, he would have to melt it. There are three terms here which perhaps are used from time [fol. 586] to time, and certainly in order to cast, you have to melt, which is a process of fusing.

By Mr. Arseneau:

Q. Now, Doctor, I would like to direct your attention to Defendant's Exhibit No. 5 for identification, which is the Barrett Patent No. 405,196, and I would like to ask you if you have had the opportunity to study this patent?

A. Yes, sir, I have.

Q. Could you tell us briefly what this patent teaches you as one skilled in the art of electrochemistry?

A. Specifically he is trying another method of applying silver chloride to a supporting electrode.

Q. In connection with Figure 2 can you tell us what "B" designates to you, and I direct your attention to lines 80 through 85 on page 1, in the right-hand column?

A. The modification apparently consists of applying what I assume in this case to be essentially a paste of silver chloride on a thin sheet of silver.

Q. I was referring to "B", by the way, Doctor.

Mr. Reilly: I would like to have the witness continue his answer.

By Mr. Arseneau:

Q. Please continue.

A. Which he then, in order to fuse, passed through [fol. 587] a flame and melted the silver chloride.

Q. Will you tell us what the reference numeral "A" in Figure 1 identifies, and what it is composed of?

A. This is a sheet of zinc which apparently is thin enough that he is able to roll it up when he desires.

Q. Doctor, I would like to direct your attention to page 1 of this Barrett patent, the left-hand column, lines 41 down through 50, and I would like to have you state in your opinion what this conveys to a man skilled in this field.

A. In this particular area he is alluding to the fact that it is apparently common practice to use ammonia, chloride of sodium, or chloride of zinc as the elestrolyte in such cells.

Q. Thank you very much. Referring back to Figure 1 of the drawing in this patent, will you tell us what "a" and "b" designate to you?

A. These are simply terminals by which an external connection can be made to the battery.

Q. Thank you very much.

Doctor, I would now like to have you turn to Defendant's Exhibit No. 6 for identification, which is a patent to Hard, No. 457.116, and I will ask you if you have had a chance to analyze and familiarize yourself with this reference? [fol. 588] A. Yes, I have studied it.

Q. Will you tell us briefly what the patent discloses to one who is skilled in the art of battery technology?

A. He is speaking again primarily of an improvement in an existing battery, in which he has used a zinc cup as one electrode of tubular form, and in this particular case he has used a rod of silver chloride.

Q. I understand. Directing your attention to Figure 1 and to the reference character "f", can you tell us what that represents?

Mr. Reilly: Where is it?

Mr. Arseneau: On page 1, over in the right-hand column, and I direct attention to line 80.

The Witness: In this paritcular case he is using silver chloride, and I am trying to refresh my memory on the way in which it was put on. This is simply a rod of silver, and he has placed a silver disc around the cast silver chloride.

By Mr. Arseneau:

Q. Can you tell us what the reference character "d" refers to?

A. That refers to the silver discs which are in contact with the silver rod in the center.

Q. How are the discs caused to be retained or held in position? I direct your attention to column 2, lines 25 to [fol. 589] 33, on page 2, if that is of any assistance in this connection.

A. What lines?

Q. 25 through 33.

A. Column 2 on page 2?

Q. Page 2.

A. I'm sorry.

Q. Page 2, the left-hand column, and I direct your attention to lines 25 through 33.

A. I don't believe he actually tells how he secured the silver discs, but apparently they are in contact with the silver rod.

Q. What I want to know is, what is retaining the silver disc within this silver chloride—I will withdraw that question and I will go on and not belabor this point, Doctor. May I direct your attention to Defendant's Exhibit No.

7, which is the Hathaway patent? Doctor, I would like to ask you whether you have had a chance to study this patent?

A. Yes, I have.

Q. And, if so, I would like to ask you what is the nature and composition of the electrodes disclosed therein?

A. Here again he has modified the method, and speaks of a cast form of silver chloride, and apparently he has much more surface exposed to the electrolyte.

Q. On page 2, the left-hand column, line 40, Doctor, [fol. 590] can you tell us what the reference to the "B" designates in this disclosure?

A. That is a silver wire which runs in the center of this cast form of silver chloride.

Q. Doctor, referring you back to the drawing itself, the upper portion of the drawing, would you tell us what the configuration shown in Figure 3 represents?

A. This is really the form of three different molds, apparently, that he had designed with the object of casting the silver chloride.

Q. Doctor, will you go over to page 2, please, the left-hand column, and I want to direct your attention, if I may, to line 37; actually it is designated line 40?

A. Yes, sir.

Q. I will ask you again, in view of that passage, what you construe the configuration in Figure 3 to represent?

A. Having indentations in the cast form of silver chloride.

Q. I understand. Directing your attention to column 1, page 1, lines 35 through 40, can you tell us how the configurations shown in Figure 3 are obtained? That is lines 35 through 40, the left-hand column on page 1.

A. These are formed by casting silver chloride into a mold, with a central silver wire.

[fol. 591] Q. Doctor, this is an aside, but is there any doubt in your mind as to what the word "cast" means in this patent?

A. It is "fused" or "melted" by heating silver chloride, pouring it into a mold and letting it solidify.

Q. I would like to refer you now, Doctor, to Defendant's Exhibit No. 8 for identification, which is the Vantenac Patent No. 184,932, and I will ask you if you have had an

opportunity to study this patent, and, if so, tell us briefly what it teaches to one skilled in the battery art?

A. Yes, I have studied this, and this is a modification of the cell of silver chloride and the zinc cell which we have been discussing before, and in this particular case he has used silver chloride as the outer electrode and a coiled zinc wire as the inner electrode.

Q. In what form is the silver chloride? In other words, how is it made?

A. This electrode is made by first putting in a silver wire or a platinum wire over a mold, in which the wire is well distributed, and then he has poured silver chloride in a liquid state into this mold, thereby getting a sort of shell.

Q. Doctor, I want to refer you to Figure 3 of this patent, if I may.

A. Yes, sir.

[fol. 592] Q. Let me also refer you to the lowermost paragraph on page 1, the right-hand side, and continuing over onto page 2, and I want to ask you what the configuration in Figure 3 means to you, and how it was obtained. I am referring particularly to the wavy or undulating line in Figure 3.

A. Repeating again, he has used this wire, which has been bent in such a way that perhaps it would give more surface contact to the silver chloride, which has solidified in a mold, in order to give more contact.

Q. You said the silver chloride was solidified in a mold?

A. Yes, sir.

Q. Doctor, I now refer you to Defendant's Exhibit No. 9 for identification, which is the Fink Patent No. 434,593, and I would like to ask you whether you have had the opportunity to study this patent?

A. Yes, I have.

Q. Will you state what it teaches to you as one skilled in the field of battery technology?

A. This is another attempt to improve the so-called chloride of silver batteries.

Q. Can you tell us, speaking now of the central figure in the drawing, which I think is designated Figure 4, and referring to the second page, line 48, can you tell us what [fol. 593] the reference character "A" designates there?

A. This indicates the silver chloride.

Q. All right. Now referring you back to column 1 of this patent, line 43, can you tell us what process was used in your opinion in connection with the silver chloride element in this patent?

A. He has melted the silver chloride and poured it into the mold.

Q. Thank you very much.

In Figure 3, can you tell us what the reference character "C" designates?

A. This is a thin strip of silver which apparently has been twisted and is to be used as a grid, so to speak, in the mold in which the silver chloride has been cast.

Q. I want to refer you to Defendant's Exhibit No. 10 for identification, which is the Pearson Patent No. 512,055. Do you have that?

A. Yes, I have.

Q. I want to ask you whether you have had an opportunity to read this patent, and if you have, will you tell the Court what it teaches you as one skilled in the battery art?

A. Yes, I have read this patent.

Q. Will you tell the Court what the electrode materials are in this Pearson battery?

[fol. 594] A. Zinc and silver chloride.

Q. Can you tell us what the reference character "D" designates in Figure 2?

A. This is a silver chloride.

Q. In what form is the silver chloride? I refer you to the right-hand column, line 60, if that is of any assistance.

A. Yes, sir. In this particular case the silver chloride was cast with a bond around a wire.

Q. What reference character is applied to the wire?

A. "E".

Q. Thank you.

A. This being of silver.

Q. Doctor White, by way of recapitulation, I would like to do this: I want to refer you briefly and go back to the Hard patent, Defendant's Exhibit No. 6, and I will refer you to Figure 1 in the Hard patent. Do you have that?

A. Yes, I have it.

Q. I am also going to re-direct your attention to Figure 3 of the Hathaway patent.

Mr. Reilly: What number is that?
Mr. Arseneau: That is Defendant's Exhibit No. 7.
Mr. Reilly: What number?
Mr. Arseneau: 454,598.

[fol. 595] By Mr. Arseneau:

Q. Do you have that?
A. Yes, sir.
Q. I am also going to re-direct your attention to Defendant's Exhibit No. 8, the Vantenac patent, and more particularly to Figure 3 in Vantenac.

Mr. Reilly: What number is that?
Mr. Arseneau: 184,932.

By Mr. Arseneau:

Q. Lastly I will direct your attention to Figure 2 of the Pearson patent, No. 512,055.
A. Hard, Hathaway and Vantenac?
Q. Hard, Hathaway, Vantenac and Pearson. I direct your attention to Figure 1 of the patent in suit, which is Trial Exhibit No. 10, and I will ask you whether, in your opinion, it would have been within the skill of an expert in your field by 1938 to embed a conductive spiral coil, as shown by Adams, in a depolarizer of fused silver chloride?

Mr. Reilly: What do you mean by that term?
Mr. Arseneau: What term?
Commissioner Lane: Fused.

By Mr. Arseneau:

Q. Doctor, will you answer my question as if we were thinking of the word "fused" in the sense it is used in the [fol. 596] Adams patent?

Mr. Reilly: Objection. I think Mr. Arseneau should state what he means by his question.

Mr. Arseneau: The witness has been applying the references, and the witness has applied at least one literature reference with "fused," and he said the word "cast" is synonymous to "fused," and I think the verbiage of the question is proper.

Mr. Reilly: The witness is asked to compare it with the Adams patent, Your Honor.

Commissioner Lane: Does "fused' in the Adams patent mean what is said in the Hayes patent?

The Witness: May I have a moment?

Commissioner Lane: Yes, sir.

Mr. Arseneau: Hayes is Defendant's Exhibit No. 2, and the definition I believe that the Court refers to is in the record.

The Witness: I don't believe I am qualified to discuss the claims, Your Honor.

Mr. Arseneau: I don't believe the witness understood the question. I do not believe he was requested to construe a claim. Will the Court repeat the question for the witness?

(Question read.)

The Witness: To clear that up, the only place that I found the word "fused" in the body of the patent is in [fol. 597] reference to "a fused drop of magnesium chloride," which is referred to in another portion. Otherwise I do not see the word "fused" used. Certainly from the standpoint of melting cuprous chloride, this is "fused" in my understanding, and certainly it is the same in each one of the cases.

Commissioner Lane: Has your question been answered, Mr. Arseneau?

Mr. Arseneau: Not to my knowledge.

Commissioner Lane: Do you want to restate it?

Mr. Arseneau: Yes.

By Mr. Arseneau:

Q. I first redirect your attention, Doctor White, to a number of patents with respect to which you have already testified, and I put Trial Exhibit No. 10 before you, which is the Adams patent, and I ask whether in your opinion it would have been within the skill of an expert in your field by 1938 to have embeded a conductive spiral coil, as shown by Adams, in a depolarizer of fused silver chloride?

A. The answer is "yes."

Q. Doctor, may I refer you to Defendant's Exhibit No. 11 for identification, which is a literature reference by Mr.

Codd, and I would like to ask you if you have had an opportunity to study this reference?

A. Yes, I have.

[fol. 598] Q. I would like to direct your attention to page 44, the lowermost paragraph, and I would like to ask you, please, to tell us what that means, that is, tell the Court what this teaches you as one skilled in the art?

A. This again is a description of De La Rue's primary cell, and it consisted of silver chloride fused around a silver wire, with the anode being zinc, and in this particular case sodium chloride was the electrolyte.

Q. Doctor, I think I am clear on this much, and I would like to refer you to Figure 1 on page 2 and ask you to explain the significance of this drawing.

A. I think he simply used this to illustrate how it would be set to obtain the EMF between two dissimilar methods.

Q. Are the electrodes indicated, Doctor?

A. As copper and zinc.

Q. Going a step further, I would like to refer you to the uppermost paragraph on page 2 and ask you what this teaches to one skilled in your field?

A. Simply that magnesium can always be used to obtain a higher voltage than with zinc.

Mr. Reilly: May I have the question and answer read, please?

(Record read.)

[fol. 599] By Mr. Arseneau:

Q. In your opinion, is there a marked difference, Doctor?

A. Repeat the question, please.

(Question read.)

The Witness: Yes, one is much more electronegative than the other. This by the way is in the category of convenience in the electrochemical system and not the common usage of the chemical system.

By Mr. Arseneau:

Q. When I said "marked difference," I was referring to magnesium. Is that what your answer was directed to?

A. Yes, sir.

Q. I understand. I would like to refer you briefly at this point to Plaintiffs' Exhibit No. 39, which is an article by Mr. Mullen and Mr. Howard, and I am going to place this reference before you, Doctor White, and direct your attention to page 541, the second full paragraph, and I will ask you, Doctor White, what significance that fine print which was put in by the Plaintiffs, has to you? I believe the Court would not frown on you reading those portions which you wish to read, Doctor White.

A. It would probably be much more concise than I could say it, but in this reference there was a discussion by H. E. [fol. 600] Haring on the paper in question, and he points out that "silver chloride, according to the patent literature, was employed extensively in the latter part of the last century as a positive electrode of batteries used for ringing doorbells and lighting gas lamps. The numerous references to the doorbell application suggest that ringing of doorbells was a popular pastime. Zinc was employed as the negative electrode because it was the best metal available for the purpose at the time. Magnesium has always been attractive to battery designers because it yields at least 0.5 volt more than zinc, is lighter in weight and has a much more favorable electrochemical equivalent. It is not surprising, therefore, that, as soon as it became commercially available, magnesium was used in a number of primary cells in conjunction with a variety of positive electrode materials."

Q. Will you tell the Court what your interpretation of that passage is?

A. That magnesium was an obvious substitute for zinc in many cases.

Q. Thank you very much, Doctor White.

Doctor, I would like to refer you to Defendant's Exhibit No. 12 for identification which is the Wood patent No. 1,696,873, and I am going to ask you if you have had a chance to read that patent disclosure?

[fol. 601] A. Yes, I have read this.

Q. Will you tell us briefly—I refer now to the left-hand column on page 1, and would you refer to lines 44 down through the last line, and give us your opinion as to what that passage means to one skilled in the art of electrochemistry?

A. I say again he was here stating that magnesium is very near the top of electrochemical series, and because of its high voltage it would produce a much better potential than a cell of the Leclanche type cell, commonly known as a dry cell.

Q. I direct your attention to Defendant's Exhibit No. 13 for identification, which is Patent No. 1,920,151 to S. Ruben, and I want to ask you if you have had an opportunity to familiarize yourself with this disclosure?

A. Yes, sir.

Q. I will ask you to tell us briefly what it teaches to you as one skilled in the art?

A. This patent is primarily concerned with the construction of a cell primarily for constant potential, and in this he has outlined the use of a number of the electronegative materials, and I should say in his terminology it states "electro positive material such as aluminum."

Q. Doctor, let me direct your attention to page 1, the [fol. 602] left-hand column, line 50, going down to the bottom, and ask you what significance that passage has to you, especially as concerns zinc or magnesium as electrode materials?

A. That he does use them for the same purpose. In his particular case they are interchangeable.

Q. Doctor, I would like now to direct your attention to Defendant's Exhibit No. 14 for identification, which is a patent to Jumau, No. 2,078,143, and I would like to ask you if you have had an opportunity to study this disclosure?

A. Yes, I have studied this patent.

Q. Will you tell us briefly what the patent means to you as one skilled in the art of electrochemistry?

A. In this particular cell he is suggesting the use of insoluble lead salts, among which are the sulphate, phosphate, chloride, bromide, iodide, et cetera.

Q. Have you finished, Doctor?

A. Using as the other electrode magnesium.

Q. I want to direct your attention to this: Do you find any teaching in this patent of metallic chloride used as a depolarizer?

A. Yes, sir, I do.

Q. Can you tell us, referring to the right-hand column, what the metallic chloride is?

A. Lead chloride.

[fol. 603] Q. I want to ask you what substance the other electrode is composed of?

A. Magnesium.

Q. Doctor, I want to direct your attention to the left-hand column on page 1, line 35, and I want to ask you if this patent teaches you anything as an expert about materials formerly used in place of magnesium?

A. Yes, it does. He apparently refers to the use of a zinc electrode, and you can get a voltage of only about one-half volt.

Q. Doctor, I would like to do this: I would briefly like to redirect your attention first of all to Defendant's Exhibit No. 11, which is this book entitled "Practical Primary Cells," and I would like to direct your attention more particularly to Defendant's Exhibit No. 12, which is the Wood Patent No. 1,696,873. All right?

A. All right.

Q. And following the same line of thought, I will direct your attention to Mr. Ruben's patent, No. 1,920,151, Defendant's Exhibit No. 13, and to Jumau, No. 2,078,143, and I also place before you in connection with the questions I am about to ask Plaintiffs' Exhibit No. 39, and I have turned to the passage which you read to the Court.

Lastly I ask you to turn back to the Hayes Patent [fol. 604] No. 282,634, which is Defendant's Exhibit No. 2 for identification. Do you have them?

A. Yes, sir, I have them.

Q. I would like to ask you this question:

I would like to ask whether in your opinion it would be within the skill of an expert in your field to substitute magnesium for the element zinc in the electrode C, shown in the Hayes patent?

A. It certainly would be.

Q. In your opinion, would it have been within the skill of one skilled in the art by around 1937 or 1938?

A. In view of all the references except this particular one.

Q. When you say "this particular one," you mean what?

A. That is the Mullen-Howard article, but I do not know the date.

Commissioner Lane: We might have a five-minute recess, gentlemen.

(Short recess.)

Commissioner Lane: You may continue, Mr. Arseneau.
Mr. Arseneau: Thank you very much, Your Honor.

By Mr. Arseneau:

Q. Doctor White, I would like to refer you again to Defendant's Exhibit No. 14, which is the Jumau Patent No. [fol. 605] 2,078,143, and I direct your attention to lines 10 through 15 in the right-hand column of page 1, and I would like to ask you what these lines on this page teach you as one skilled in the art concerning the electrolyte?

A. It points out that the electrolyte does not take part in the reactions, and it is not necessary to use an acid or basic electrolyte which will attack the magnesium, and it goes on to state:

"It is sufficient to use as electrolyte a dilute solution of an alkaline or alkaline-earth salt (sulphate, phosphate, chloride, bromide, iodide, etc.) to obtain sufficient conductivity."

In other words, any of these could be used to get conductivity.

Q. I want to direct your attention to Defendant's Exhibit No. 15 for identification, which takes the form of excerpts from a Manual of Chemistry, and I have photostated the book.

Mr. Reilly: Defendant's Exhibit No. 15?

Mr. Arseneau: Defendant's Exhibit No. 15 for identification.

Mr. Reilly: Has it been noticed?

Mr. Arseneau: No, it has not been noticed and it is not being relied on as an anticipation.

[fol. 606] Mr. Reilly: I object because it has not been noticed, and under the terms of our stipulation it is not proper to introduce it.

Commissioner Lane: Mr. Arseneau, you state that this is not being relied upon as anticipation, so let us pass it over.

Mr. Arseneau: Your Honor, the literature which we just

referred to is similar. We have Defendant's Exhibit No. 16 for identification, which is in the book, and takes the form of excerpts from a chemical text entitled "Essentials of General Chemistry" by Hopkins and Bailar, a copy of which we will also hand to Plaintiffs. Once again this is not being used as an anticipation.

By Mr. Arseneau:

Q. Doctor, in connection with Defendant's Exhibit No. 14, the Jumau patent, you will recall that you used the term "alkaline-earth salt." I would like to refer you to Defendant's Exhibit No. 15, which is the Simon literature, and more particularly to page 261, and I would like you to tell the Court what that passage teaches you concerning the element of alkaline-earths?

A. Simply that those metals, magnesium, calcium, strontium and barium are being considered to be alkaline-earth metals.

Mr. Reilly: I will stipulate that magnesium sulphate is [fol. 607] an alkaline salt.

Mr. Arseneau: And also magnesium earth salt?

Mr. Reilly: Yes, sir.

Mr. Arseneau: And is that your position on magnesium-chloride?

Mr. Reilly: We will also stipulate that, Your Honor.

Mr. Arseneau: We will stipulate to that, Your Honor.

By Mr. Arseneau:

Q. Now, Doctor White, I want to return to the Jumau patent, Defendant's Exhibit No. 14 for identification, and I want to ask you, in your opinion, what is the reason for using an alkaline-earth salt, such as a chloride or a sulphate in the electrolyte?

A. Simply to render the electrolyte conductive.

Q. Thank you.

Doctor, I would like to ask you this question: I would like to go back to the Hayes Patent No. 282,634, which is referred to as Defendant's Exhibit No. 2 for identification. Have you found the place?

A. Yes, I have.

Q. I would like to ask you this question: Whether in your opinion the magnesium chloride and the magnesium sulphate of Jumau has a different function than the sodium chloride which is referred to in the Hayes patent which you [fol. 608] have testified with respect to?

A. It does not.

Q. Thank you very much.

Doctor, I would now like to direct your attention to Defendant's Exhibit No. 17 for identification, which is a British Patent No. 301,923, and I want to ask you whether you have had an opportunity to familiarize yourself with this disclosure, Doctor?

A. Yes, sir.

Q. Directing your attention to page 1, the left-hand column, lines 30 through 37, will you give the Court your opinion as to what this teaches a person skilled in the art of battery technology?

A. This would indicate that magnesium chloride or sulphate has been used as an electrolyte in a cell which had used a magnesium anode.

Q. Doctor, I would like to ask you this question concerning Defendant's Exhibit No. 17 for identification:

In your opinion, does the action of these salts differ from the action of the sodium chloride referred to in the Hayes patent, Defendant's Exhibit No. 2 for identification.

A. No, in my opinion, it does not.

Q. I would like to refer briefly to the Adams patent, Trial Exhibit No. 10, and ask you if you find any reference [fol. 609] in that patent to the use of magnesium chloride and magnesium sulphate?

Mr. Reilly: I will concede that the Adams patent does refer to those substances.

By Mr. Arseneau:

Q. Doctor, I would like to ask you this question: In these patents which mention the use of magnesium chloride, would the use in the form of a fused drop cause it to function differently than sodium chloride in increasing the conductivity of the electrolyte?

A. Will you define "fused"?

Q. I am afraid to answer that. I will ask you, sir, how you define "fused"?

Mr. Reilly: I assume you mean in this case by "fused" that the magnesium chloride is liquefied by heat and solidified by the withdrawal of heat.

By Mr. Arseneau:

Q. Trial Exhibit No. 10, the Adams patent, Doctor, will you turn over to page 2, the left-hand column in line 6?

Mr. Reilly: Did he answer your question?
Mr. Arseneau: Excuse me. Let me state the question.
Mr. Reilly: You asked the question.
Mr. Arseneau: Is there an answer to the question?
The Witness: You better read it back, Mr. Reporter.

[fol. 610] (Question read.)

The Witness: No, sir, I believe not. It is simply a matter of convenience.

By Mr. Arseneau:

Q. Doctor White, let me ask you this: I am going briefly to redirect your attention to the Jumau Patent No. 2,078,143, and I will redirect your attention to British Patent No. 301,923, and I want to ask you briefly to refer back to the Hayes patent, which is Defendant's Exhibit No. 2. Do you have that?

A. Yes, sir, I have that.

Q. I want to ask you this question, Doctor: Whether in your opinion, by 1938, it would have been within the skill of an expert in your field to have employed magnesium chloride and magnesium sulphate instead of the sodium chloride referred to in the Hayes patent specification?

A. Yes, I think it would be known to them.

Q. I would like to ask you this, Doctor: You testified with reference to British Patent No. 301,923, and I would like to ask you to give us your opinion as to whether, in view of that British patent, the substitution of the magnesium electrode for the zinc electrode would have been within the skill of a person skilled in the field of electrochemistry?

A. Yes, I think it would be.

[fol. 611] Q. Dr. White, in view of the prior art patents to which you have testified on so far, I want to ask you to give us your opinion on a number of questions, and I will try to give them to you in turn.

First of all, I would like to have you give us your opinion as to whether by 1938 it would have been within the skill of a person trained in your field to construct an electrolytic cell in which a magnesium electropositive electrode was positioned in a container?

A. Yes, it would have been.

Q. I want to ask you this: Will you give the Court your opinion as to whether by the same date, 1938, it was within the knowledge of a person trained in electrochemistry to equip the end of such an electropositive electrode with an exterior positive terminal?

A. I think this would have been obvious.

Q. Doctor, by 1938, in your opinion, would it have been within the skill of a person trained in electrochemistry to employ with such a cell, a fused silver chloride electrode, to be positioned to extend into such a container?

A. Yes, I believe it would have been obvious by that time.

Q. Doctor, would it have been obvious—I won't say "obvious," but would it have been within the knowledge of [fol. 612] a person skilled in the art to embed a metal terminal or affix a metallic terminal to such a fused silver chloride electrode?

A. Yes, sir.

Mr. Reilly: Without interrupting, may I enter a general objection to this entire line of questions?

Commissioner Lane: Overruled.

Mr. Arseneau: Thank you, Your Honor.

By Mr. Arseneau:

Q. Doctor, in your opinion, referring to embedding a copper coil within a fused silver chloride electrode in a magnesium fused silver chloride system, would that have been in your opinion within the skill of a person trained in electrochemistry?

A. Yes, it would have been.

Q. Doctor, I want to go back. In a cell having a fused silver chloride electrode and a magnesium electrode, would it have been within the knowledge of one skilled in electrochemistry to provide a body of water and magnesium sulphate between those electrodes?

A. I think it would have been obvious.

Q. I will ask you, Doctor, whether in your opinion by 1938, in view of the art references you have testified to so far, you are able to give us your opinion as to whether it would be within the skill of a person trained in electro- [fol. 613] chemistry or battery technology, in a cell using fused silver chloride-magnesium, to employ a liquid which included magnesium sulphate and fused magnesium-chloride between the electrodes?

A. I would qualify it and ask why he would fuse the magnesium chloride. Other than that, I would say yes.

Q. Doctor, I would like to direct your attention back to Defendant's Exhibit No. 7 for identification, the Hathaway Patent No. 454,598, and I would like to ask you something. I know you have already testified with respect to this patent but I want to ask you if you understand the configuration shown in Figure 2 of this patent?

A. I believe I do.

Q. In view of this patent, I will ask you for your opinion as to whether or not by about 1938 you believe that to an expert in the art the use of a tubular electropositive electrode of zinc, with a fused stick of silver chloride, positioned internally therein, would have been within the skill of a person trained in electrochemistry?

A. It certainly would.

Q. Doctor, I will refer you to Book No. 2, Defendant's Exhibit No. 18, to the first patent included in the book. Do you have that?

A. Yes, I have it.

Q. It is the Thurnauer Patent No. 552,211. Doctor [fol. 614] White, I would like to ask you whether you have had the opportunity to study Defendant's Exhibit No. 18 for identification?

A. Yes, I have.

Q. Would you tell the Court briefly what this teaches you as a person trained in the art of electrochemistry?

A. Briefly he is referring to the apparently common

usage of copper oxide as a depolarizer in primary batteries at that time, 1895, but apparently there was some difficulty and he is suggesting an improvement of some kind or other in mixing copper chloride with copper oxide.

Q. I understand. I want to direct your attention to the right-hand column, line 94, and I want to ask you what in your opinion the function of the copper chloride that is used is?

A. The patentee feels that copper chloride not only acts as a binding material but also as a depolarizer and thereby increases the efficiency of the plate.

Q. Doctor, I want to direct your attention to line 66, in the right-hand column, if I may, and I want to ask you if you will tell the Court what it teaches you concerning the preparation of the copper chloride?

A. He refers here to using six parts of copper oxide to one part of copper chloride, but it also indicates that [fol. 615] this could vary depending on the quality of the plate.

Q. I think you are a little bit above the line to which I directed your attention.

A. I'm sorry.

Q. I direct your attention to line 66, in the right-hand column.

A. All right. In this line he goes on to describe the method by which he prepares this mixture of copper oxide and copper chloride.

Q. Would you go a step further and tell us what the technique means to you, or how you interpret this passage?

A. Well, in this particular case, by adding hydrochloric acid to the copper oxide, he certainly gets copper chloride.

Q. Is there only one variety of copper oxide?

A. There are two.

Q. Would you tell us what the end products are of adding hydrochloric acid to those two varieties of copper oxide?

A. In each case certain appreciable portions of the corresponding cuprous or cupric chloride is formed from the original oxide, depending on which oxide is present.

Q. Doctor, referring to page 2, line 6, will you tell the Court what the excitant or the electrolytic fluid is in this battery?

[fol. 616] A. He refers to the fact that an alkaline solution or a saline solution can be used, but also indicates that most any excitant or electrolyte, I would say, could be used so long as it is not acid in its nature.

Q. I would like to ask you this: If the copper chloride referred to in this patent is regarded as cupric chloride, would you tell us what would happen if it were immersed in a saline solution?

A. Certainly if cupric chloride is formed, it would all dissolve to a considerable extent, and no doubt would destroy at least that part of the electrode.

Q. Let me ask you this question, sir: Can you tell us what the solubility of the cuprous chloride is relative to the cupric chloride?

A. From previous testimony, apparently, and from my own knowledge, it is difficult to say. I do not know.

Q. Doctor. directing your attention to the right-hand column, line 94, will you give us your opinion as to what copper chloride they are referring to as a depolarizer?

A. Certainly they must have been referring to cuprous chloride. Otherwise, the electrode would disintegrate.

Q. Doctor, I want to refer you now to Defendant's Exhibit No. 19, which is a British Patent No. 4341 to Skrivanoff, and I want to ask you if you have had the [fol. 617] opportunity to read this patent, Doctor, and, if so, tell us briefly what it teaches you as one skilled in the battery art?

A. Yes, I have read this and it represents another early attempt to build bell-ringing primary batteries.

Q. I will direct your attention to page 2 of this British patent, Doctor, and I want to ask you to start at line 31, column 1, and can you tell us the purpose and function of some of the ingredients described thereat?

A. The purpose in this particular disclosure is not too clear, apparently at that time—and that was in 1880—and they were not fully conversant with this, but it certainly indicates the use of cuprous chloride as a part of the depolarizing action in this particular cell because there are considerable portions of cuprous chloride in this mix.

Q. Doctor, I would like to ask you this question: Would you give us your opinion as to whether the cuprous chloride referred to in this British patent has a function which

is different from the copper chloride to which you referred in Thurnauer?

A. In my opinion this did contribute to the depolarizing action, even if the author did not suggest it, and certainly he is suggesting to anybody else a possible depolarizer.

Q. Doctor, in this Skrivanoff patent, I would like to direct your attention back to page 1, and I would like to [fol. 618] direct your attention to lines 18 and 19, and I would like to ask you to tell the Court what, if anything, this reference teaches you concerning the use of zinc and magnesium electrodes.

A. This gentleman certainly recognizes the need for a higher voltage battery, and his load resistance was higher, and I assume that the bell is located further away, and by replacing the zinc with magnesium, he could get a higher voltage, and that is how it was developed.

Q. Thank you very much.

I would like now to refer you to Defendant's Exhibit No. 20, which is a British Patent No. 49, issued to Wensky; do you have that, Doctor?

A. I have.

Q. I would like to ask you if you have had the opportunity to study and analyze the disclosure in this patent, Doctor?

A. Yes, I have.

Q. Will you tell us briefly what this teaches a person skilled in the art of electrochemistry?

A. In this particular case, which was in 1891, he appreciated the cost of the silver chloride which had been first used by Marie Davy, and is suggesting the use of a depolarizing agent, namely, subchloride of copper.

Q. Thank you very much.

[fol. 619] Directing your attention to lines 38 to 40, and to the drawing which accompanies this patent, I wonder if you would tell us what use is made of z-z, the spaces shown in Figure 1?

A. It would be my opinion that this is apparently a space in which he has placed subchloride, cuprous chloride.

Q. Once again, Doctor, referring to line 16, will you tell us what the patentee there called it or what name the patentee applies to the cuprous chloride or the subchloride?

A. A depolarizing agent.

Q. Doctor, I would like to ask you this question: If the subchloride of copper mentioned in this patent is taken, in your opinion does the function and purpose differ from that of the copper chloride mentioned in Mr. Thurnauer's patent, Defendant's Exhibit No. 18 for identification?

A. Only in the matter of degree. In the Thurnauer patent he had a mixture of copper oxide and copper chloride.

Q. Speaking particularly of the copper chloride in Thurnauer, does it have a function or purpose which is different from the subchloride of copper referred to by Wensky?

A. Only to the degree that it might, as the patentee indicates, also be used as a bonding agent.

Q. I understand.

Doctor, I direct your attention to Defendant's [fol. 620] Exhibit No. 21 for identification, which is the Journal of the Chemical Society, Volume 53, entitled "The Constitution of the Copper-Zinc and Copper-Tin Alloys," by A. P. Laurie, and ask you if you have had the opportunity to read that article?

A. Yes, I have studied the article.

Q. Would you tell the Court briefly what the problem is which is solved therein, or what it teaches to one skilled in the art?

A. This paper by Laurie describes his study of The Constitution of the Copper-Zinc and Copper-Tin Alloys, in which he is trying out a new method, what he considers to be a new method in determining compound formations between copper-zinc and copper-tin.

Q. Doctor, in that connection, I would like to direct your attention to page 111 in this exhibit. In the central paragraph on page 111, I would like to ask you in connection with that central paragraph if you will tell us what the test cells and the electrodes of the test cells consist of?

A. Primarily this simply means that apparently by this time, 1888, I believe, that this copper cuprous chloride had been recognized as a standard system which would also give an equal value, which could be depended upon, and he was simply using this as a reference electrode in a study [fol. 621] of the diagram.

Q. Doctor, page to the front of the book, and will you please refer briefly to Defendant's Exhibit No. 1, which is the Niaudet reference?

A. Yes, sir.

Q. Doctor, I would like to ask you whether it is correct to state that in your former testimony you mentioned this reference as containing a disclosure of platinum chloride, lead chloride and perchloride of iron, in addition to fused silver chloride?

A. I am sorry, I didn't get that.

Q. I will repeat the question. Have you had the opportunity to glance at that or to refresh your recollection of it?

A. Yes, I have.

Q. I ask you whether it is correct or not that in your former testimony you mentioned this reference as disclosing platinum chloride, lead chloride and perchloride of iron, in addition to silver chloride?

A. Yes.

Q. Doctor, I would like to ask you this: Would you give us your opinion as to whether a person skilled in electrochemistry by 1938 would have been aware of the possibility of employing metallic chlorides other than silver chloride [fol. 622] as depolarizer electrodes?

A. Yes, sir, it would have been obvious.

Q. Doctor, I will ask you this:

I will redirect your attention to Defendant's Exhibit No. 18, which is the Thurnauer patent, and I will also redirect your attention to the Skrivanoff British Patent No. 4341, which is Defendant's Exhibit No. 19, and I will redirect your attention to British Patent No. 49 to Wensky, Defendant's Exhibit No. 20 for identification, and to the Laurie article, with respect to which you have just testified, and I am going to ask you if you will tell the Court whether by 1938, in your opinion, the use of cuprous chloride as a depolarizing electrode would have been apparent to one skilled in the battery art?

A. Yes, I believe it would be.

Q. Thank you very much.

Doctor, I am going to refer you to Defendant's Exhibit No. 2, which is the Hayes Patent No. 282,634. Do you have that, sir?

A. I have it.

Q. I want to refer you to Figure 2 of that Hayes patent, and I am going to ask you whether in your opinion by 1938 the use of a fused cuprous chloride electrode for the

fused silver chloride electrode would have been within the [fol. 623] skill of a person trained in electrochemistry or trained in battery technology?

A. Yes, sir.

Q. Doctor, I want to redirect your attention to Defendant's Exhibit No. 14, which is the Jumau Patent No. 2,078,143. Do you have that?

A. Yes, I have it.

Q. I want to direct your attention to the top right-hand column of Figure 1, and I want to ask you whether you find any mention of the use of magnesium with a metallic chloride depolarizer?

A. Yes, I do.

Q. I am going to ask you what that metallic chloride depolarizer is composed of or what elements are involved.

A. Lead chloride.

Q. Doctor, I will not make you turn back to Thurnauer or Wensky or Skrivanoff, but in your opinion would it have been within the skill of an expert in your field to use a cuprous chloride depolarizer in place of this lead chloride depolarizer disclosed in the Jumau patent?

A. I think it would have been an obvious choice.

Q. You testified, or you have answered a question on the substitution of cuprous for lead chloride, and I am going to ask you whether in your opinion the substitution [fol. 624] of a fused cuprous chloride depolarizer for the lead chloride electrode taught by Jumau would have been within the skill of a person trained in the art by 1938?

A. Yes, it would have been.

Q. Doctor White, I have a series of opinion questions which I intend to propound. The first of these opinion questions is this:

In view of the prior art patents on which you have testified, would you give the Court your opinion as to whether by 1938 it was within the skill of a person trained in electrochemistry to construct a voltaic cell in which a magnesium electropositive electrode was positioned within a container?

A. Yes, sir, it would have been.

Q. Doctor, will you give your opinion whether by 1938 it would have been within the ordinary skill of a trained

electrochemist to equip such an electrode with an exterior terminal?

A. Yes, I think so.

Q. I want to ask you whether by 1938, in your opinion, it would have been within the skill of a person trained in electrochemistry, with such a cell of the type you testified to, to have employed a fused cuprous chloride electrode positioned to extend into the same container?

A. Yes, sir.

[fol. 625] Q. I want to ask you whether it would have been within the skill of a trained electrochemist or one trained in battery technology, to affix or embed a metallic terminal within such fused cuprous chloride electrode?

A. Yes.

Q. I want to ask you, in view of the art applied or testified to by you, whether it would have been within the skill of a person trained in the field of electrochemistry, by 1938, to provide a liquid body of water and magnesium sulphate between the magnesium and the fused cuprous chloride electrodes?

A. Yes, sir.

Q. Doctor, in connection with such a fused cuprous chloride electrode, I want to ask you whether embedding a copper coil within said cuprous chloride would have been by 1938 within the skill of a trained electrochemist?

A. Yes, I believe it would be.

Q. Doctor, I will ask you to refer back to Defendant's Exhibit No. 7, please, which is the Hathaway Patent No. 454,598. Doctor, you testified that you were familiar or understood Figure 2 in a previous line of questioning, and I want to ask you this question again:

I want you to tell the Court whether by 1938, in [fol. 626] your opinion, the expedient of using a tubular electropositive magnesium electrode or zinc electrode with a fused stick of cuprous chloride located therein would have been within the skill of an expert trained in the field of electrochemistry?

A. Yes, it would have been.

Q. Thank you.

Doctor, I want to ask you now to refer to Defendant's Exhibit No. 22 for identification, which is in the Parkhurst Patent No. 269,454.

A. Yes, sir.

Q. Do you have it?

A. Yes, I have it.

Q. Have you had a chance to study or analyze the disclosure of this Parkhurst patent?

A. Yes, I have studied it.

Q. Will you tell us briefly what it teaches one skilled in the art of electrochemistry?

A. In this particular Galvanic Battery, as it is entitled, he is using one electrode of zinc, which he specifies can be in any well-known shape. His negative plate, as he terms it, is cylindrical, and he uses a rod of carbon, around which he mixes granulated gas-retort carbon, along with a granulated mixture of black oxide of manganese.

Q. Doctor, I would like to direct your attention to [fol. 627] page 2, over in the right-hand column, lines 65 through 68, and I would like to ask you what that means to you as one skilled in the art? A. In this particular case he has employed the use of granulated carbon with chloride of mercury as a depolarizer.

Q. I understand. I am going to ask you now to direct your attention to Defendant's Exhibit No. 23 for identification, which is the Heil Patent No. 653,770, and I am going to ask you whether you have had the opportunity to read the Heil patent?

A. Yes, I have read it and studied this patent.

Q. Will you tell the Court briefly what this patent teaches you as an electrochemist?

A. In this particular patent he has used a salt of mercury as a depolarizer by mixing with carbon.

Q. Doctor, you have testified with respect to Parkhurst, and you have also testified with respect to Heil. I am going to ask you now, please, to return to Defendant's Exhibit No. 1 for identification, which is this Niaudet article. Do you have that, sir?

A. Yes, I have it.

Q. I am going to ask you, please, to turn to page 209 of that exhibit.

A. Yes, sir.

[fol. 628] Q. First of all, do you find any mention of metallic chloride made therein?

A. Yes, he is referring to the use of perchloride of iron.

Q. Doctor, in connection with the last paragraph on page 209, will you tell the Court what import this has or what significance it has to you?

A. The pieces of carbon have been used along with the perchloride of iron depolarizer.

Q. Do you find any date stamped there?

A. The book itself was published in 1880, and he was referring to the prior art, I guess, or in this case the literature.

Q. Doctor, I would like to ask you this: In view of your testimony in connection with Parkhurst, and your just mention of Heil, and in view of your testimony just now I would like to ask whether in your opinion the expedient of fusing a metallic chloride with carbon by 1938 would have been within the skill of a person trained in electrochemistry?

A. Yes, I think it would have been.

Q. Doctor, will you turn to Defendant's Exhibit No. 24, which is the U. S. patent to Harrison, No. 1,522,121?

Mr. Reilly: I am very sorry to say this, counsel, but the patent we were noticed on was 1,522,121, and the reference [fol. 629] we just had was 1,522,121, and apparently Mr. Arseneau has got the wrong patent. If I could take a look at this, I would appreciate it, because this is the first I have seen it.

Commissioner Lane: We will have a five-minute recess.

(Short recess.)

Commissioner Lane: All right, gentlemen.

Mr. Reilly: Your Honor, I have had an opportunity to skim through this patent, which is six or seven pages long, and it is different than the one which was noticed in the list. I am going to enter an objection to its reception primarily because Mr. Arseneau stated he had noted a copy of this patent on his list, and he has produced one that he must recognize as irrelevant.

That having occurred, as a matter of courtesy between attorneys, and also to give fair notice, he should have informed me that he had discovered an error in his list, so as to give me an opportunity to get a copy and study it.

Commissioner Lane: Is this to be used as an anticipation or with respect to the state of the art, Mr. Arseneau?

Mr. Arseneau: The Harrison patent is to be used in connection with the state of the art.

Mr. Reilly: With that statement, it is all right, Your Honor.

Commissioner Lane: You may proceed.

[fol. 630] By Mr. Arseneau:

Q. Doctor White, will you refer to Defendant's Exhibit No. 24 for identification, which is the Harrison Patent No. 1,522,121, and I am going to ask you whether you have had the opportunity to study this patent?

A. Yes, I have.

Q. And, if so, will you state briefly what it teaches you as one skilled in the art?

A. I see the patent describes several methods of constructing a sea water battery, in which he can get power by using the sea as an electrolyte, with various types of electrodes.

Q. I would like to direct your attention to Figure IV in this patent, and I would also like to direct your attention to page 4, the left-hand column, lines 20 through 39, and I would like to ask you if you would identify for us the materials which the parts 22 and 23 in Figure 4 are composed of?

A. 22 is a copper tube and 23 is a magnesium tube.

Q. What is the fluid between these parts 22 and 23?

A. Seawater.

Q. Doctor, I am going to refer you to page 3, and on that page I will direct your attention to lines 10 through 15, and I am going to ask you if you will tell us what that patent teaches a person skilled in electrochemistry, and [fol. 631] what import the passage has?

A. Taking the long sentence which precedes it, he implies or poses the suggestion that extending the copper electrode actually increases its characteristics, and he guesses that it might be a basic chloride.

Q. I understand.

Doctor, in this connection I am going to refer you briefly to Defendant's Exhibit No. 18, which is the Thurnauer patent, which you testified about previously, and I will refer you to the Wensky British Patent No. 49 in 1891, and I am going to ask you, in view of these patents, the

Thurnauer and Wensky patents, whether the substitution of cuprous chloride as a depolarizer for the element 22 of Harrison would in your opinion have been by 1938 within the skill of one who was a trained electrochemist?

A. Yes, I think it would have been.

Q. Doctor, in view of the art testified by you today, will you give the Court your opinion as to whether the use of fused cuprous chloride in place of element 22 in Harrison would have been within the ordinary skill of an expert trained in your field?

A. Yes, it would have been.

Q. Doctor, I would like to ask you this question:

In a reserve type cell, which has a metallic chloride [fol. 632] electrode and is charged with water, can you tell us whether as between zinc or magnesium, which would corrode or eat away faster or more rapidly?

A. Are you referring now to the zinc or magnesium?

Q. Yes, I am.

A. Certainly in most circumstances the magnesium would self-discharge much more rapidly than the zinc, although there are certain inhibitors which can be used to slow up the self-discharge of the magnesium.

Q. Sir, in a reserve type cell would you normally add the water electrolyte prior to the time that you intended to use the cell?

A. Will you repeat the question, please?

Commissioner Lane: Read the question, Mr. Reporter, please.

(Question read.)

The Witness: I would qualify that by saying, you would add it as you started to use the cell.

By Mr. Arseneau:

Q. Let me ask you this, Doctor: Can you give us your opinion as to what happens to the cuprous chloride electrodes in the various trial exhibits about which the witnesses have testified heretofore, if they are exposed to a damp atmosphere?

A. Are you referring only to the cuprous chloride?

[fol. 633] Q. Yes.

A. They would perhaps absorb some moisture.

Q. How can you guard against that?

A. By either sealing the cell—and a lot of them are in vacuum or packed for shipment by using a desiccant—or by evacuation.

OFFERS IN EVIDENCE

Mr. Arseneau: Your Honor, I would now like formally to move into evidence all of Defendant's Exhibits marked for identification Nos. 1 through 24.

Mr. Reilly: No objection.

Commissioner Lane: Defendant's Exhibits Nos. 1 through 24 are received in evidence.

(Elementary Treatise on Batteries, Niaudet (1880), Cover sheet, Page ix, pages 200-209 received in evidence as Defendant's Exhibit No. 1.)

(U. S. Patent No. 282,634 to Hayes (1883) received in evidence as Defendant's Exhibit No. 2.)

(Galvanic Batteries, Bottone (1902), Cover sheet, Pages 172-177, received in evidence as Defendant's Exhibit No. 3.)

(Primary Batteries, Carhart (1891) Cover sheet, pages 62-65, received in evidence as Defendant's Exhibit No. 4.)

(U. S. Patent No. 405,196—Barrett (1889) received in evidence as Defendant's Exhibit No. 5.)

[fol. 634] (U. S. Patent No. 457,116—Hard (1891) received in evidence as Defendant's Exhibit No. 6.)

(U. S. Patent No. 454,598—Hathaway (1891) received in evidence as Defendant's Exhibit No. 7.)

(U. S. Patent No. 184,932—Vantenac received in evidence as Defendant's Exhibit No. 8.)

(U. S. Patent No. 434,593—Fink (1890) received in evidence as Defendant's Exhibit No. 9.)

(U. S. Patent No. 512,055—Pearson (1894) received in evidence as Defendant's Exhibit No. 10.)

(Practical Primary Cells, Codd (1929) Cover sheet, Page 1-3, 43, 44, 78, 79, 80, 81, 110, 117, received in evidence as Defendant's Exhibit No. 11.)

(U. S. Patent No. 1,696,873—Wood (1928) received in evidence as Defendant's Exhibit No. 12.)

(U. S. Patent No. 1,920,151—Ruben (1933) received in evidence as Defendant's Exhibit No. 13.)

(U. S. Patent No. 2,078,143—Jumau (1937) received in evidence as Defendant's Exhibit No. 14.)

(Manual of Chemistry, Simon (1905) Cover sheet, Page 216 received in evidence as Defendant's Exhibit No. 15.)

(Essentials of General Chemistry, Hopkins & Bailar (1946) Cover sheet, Pages 371, 372; fly leaf, rear cover, received in evidence as Defendant's Exhibit No. 16.)

[fol. 635] (British Patent No. 301,923—Ferrabino (1928) received in evidence as Defendant's Exhibit No. 17.)

(U. S. Patent No. 552,211—Thurnauer (1895) received in evidence as Defendant's Exhibit No. 18.)

(British Patent No. 4341 (1880-Series) Skrivanoff received in evidence as Defendant's Exhibit No. 19.)

(British Patent No. 49 (1891) Wensky received in evidence as Defendant's Exhibit No. 20.)

(Journ. Ch. Socy., Vol. 53 (1888) pp 104-116 Constitution of Copper-Zinc, Copper-Tin Alloys,—Laurie received in evidence as Defendant's Exhibit No. 21.)

(U. S. Patent No. 269,454—Parkhurst (1882) received in evidence as Defendant's Exhibit No. 22.)

(U. S. Patent No. 653,770—Heil (1900) received in evidence as Defendant's Exhibit No. 23.)

(U. S. Patent No. 1,522,121—Harrison (1925) received in evidence as Defendant's Exhibit No. 24.)

Mr. Arseneau: I believe that terminates our direct examination of Doctor White, Your Honor.

Commissioner Lane: Will there be cross-examination of Doctor White?

Mr. Reilly: Could I have a moment?

Commissioner Lane: Yes, sir; off the record.

(Discussion off the record.)

[fol. 636] Commissioner Lane: I understand the cross-examination may consume only five minutes, so you may go ahead, Mr. Reilly.

Mr. Reilly: Thank you, Your Honor.

Cross-examination

By Mr. Reilly:

Q. Doctor White, I believe you indicated that cuprous chloride was old in the battery art in 1888 by Laurie, and in 1891 by Wensky and 1895 by Thurnauer. Is that correct?

A. Yes, sir.

Q. And that magnesium was old in the battery art in 1880 by the Skrivanoff patent. Is that correct?

A. Yes, sir.

Q. And that silver chloride was old in the battery art by 1880 by Niaudet?

A. Yes, sir.

Q. And that the use of water was shown by Volta in 1820?

A. Earlier than that.

Q. Doctor, how is it that it took a man skilled in the art, I think you said, until 1938, to put the combination together, where all the components had been known in the art since 1888 for the last one? How do you explain the time lapse of 50 years or half century?

A. I think this can't very well be answered. Maybe [fol. 637] there was no need for it. Somebody has to have the need and the opportunity. I don't know.

Q. You don't know?

A. That is right.

Q. Can you show me any reference that discloses, that is one of the references which you studied which discloses a magnesium-cuprous chloride-water battery or a magnesium-silver chloride-water battery?

A. Will you repeat the question, please?

Mr. Reilly: Read the question, Mr. Reporter, please.

(Question read.)

The Witness: Certainly not a cuprous chloride-mag-

nesium battery, but certainly a silver chloride-magnesium battery. There are places where that has been indicated.

By Mr. Reilly:

Q. Could you show any such references?

A. It may take a little time but I can look (examining papers). I think that is in Pearson, which is Defendant's Exhibit No. 10.

Q. Did you say Pearson?

A. Pearson, yes, sir.

Q. What is the number?

A. Letters Patent No. 512,055.

Q. 512,055?

[fol. 638] A. Yes, sir, and he refers to zinc or other electropositive material.

Q. Zinc or other electropositive material?

A. Yes, sir.

Q. Do you have any other references in answer to my question?

A. I believe that in British Patent No. 301,923 to Ferrabino, Defendant's Exhibit No. 17, sir.

Q. Ferrabino shows what, sir?

A. I'm sorry, that is not silver chloride (examining material). I'm sorry to take so long.

Q. It is quite all right.

A. There was reference to it in Defendant's Exhibit No. 19, the Skrivanoff patent, and that is with reference to the cuprous chloride depolarizer. You will find he refers to zinc being replaced by magnesium.

Q. Did it also disclose the use of very concentrated solution of chromic acid with magnesium is used instead of zinc, referring to page 3, lines 26 through 28?

A. That is correct.

Q. Doctor, have you put together the mixture described on page 2, the protochloride with sulphuric acid?

A. I have not.

Q. Thank you, Doctor.

[fol. 639] Has anybody else ever put it together for you and given you a sample?

A. No, sir.

Q. Have you any information as to what the residual

product, after the combination is made, would contain, and would it still contain cuprous chloride?

A. I have the disclosure of the patentee, and that is all the information I have.

Q. That is all the information you have on the subject?

A. Yes, sir.

Q. Thank you, Doctor.

Returning to the answer before concerning the need for the battery——

A. What?

Q. Concerning the need for the use of the battery, Doctor, were there submarines and warships and were there sinkings in World War I?

A. Quite a few.

Q. Are you familiar with the Italian sea battery which was put in evidence?

A. I am.

Q. Is that a useful device in case of sinking?

A. It could very well be.

Q. Does the Navy have submarine devices at the present [fol. 640] time?

A. I would imagine so but I have no first-hand knowledge.

Q. Are you a submarine specialist, Doctor?

A. The finest—I have not qualified, no. You know what this means, of course. I am not an engineer.

Q. But you have some experience with submarines because of your Navy work, and you testified you did something with the atmosphere in submarines?

A. That is correct, and also their batteries.

Q. Also their batteries?

A. Yes, sir.

Q. Do submarines take torpedoes?

A. They do.

Q. How long have they done that?

A. From the year one, I imagine.

Q. Do you power torpedoes today with cuprous chloride-magnesium-water activated batteries or silver chloride?

A. I can't answer that.

Q. This is an article or a page from Aviation Week, July 11, 1960, and is entitled "Missile Engineering," and it says:

"Navy Orders Homing Torpedo Production," and at the bottom there is a picture of the torpedo and two batteries at the left-hand side and they are shown there and it says:

[fol. 641] "Silver Chloride and Magnesium Plates are Used in the Mk 61 Sea Water Battery (at left)."

A. What is the question?

Q. The question is, does the Navy at the present time power torpedoes with cuprous chloride-magnesium batteries or silver chloride?

A. Personally I can't answer that. This is only hearsay as far as I am concerned.

Q. I think the year one answer was adequate. Did they have torpedoes in World War I?

A. Yes, sir.

Mr. Reilly: I think I have finished. Thank you very much, Doctor. I appreciate your staying.

Commissioner Lane: Any redirect, Mr. Arseneau?

Mr. Arseneau: Yes, Your Honor.

OFFER IN EVIDENCE

Mr. Reilly: I would like to have this article marked and entered as Plaintiffs' Exhibit No. 43, Your Honor, and I will tear it out.

Mr. Arseneau: What purpose is it being offered for? Our witness did not vouch for it, and it is hearsay, and for what purpose is it being offered?

Mr. Reilly: To show the state of the art.

Mr. Arseneau: I will go along with that.

Commissioner Lane: Plaintiffs' Exhibit No. 43 will be [fol. 642] received in evidence.

(Page 129 and 130 from Aviation Week for July 11, 1960, entitled "Missile Engineering," received in evidence as Plaintiffs' Exhibit No. 43.)

Redirect examination.

By Mr. Arseneau:

Q. Doctor White, I believe when Mr. Reilly initiated his cross-examination of you, he asked you the question why if so many of the components and elements were known in

the art by 1938 or 1939, somebody had not put them together or assembled them.

I would like to hand you Plaintiffs' Exhibit No. 39, and I would like to direct your attention to page 541, the left-hand side, to the discussion by Mr. Haring, and I would like to ask you, if you would, to give us your opinion as to what that means, and I do not think the Court would object if you read that portion of it into the record.

Commissioner Lane: It was read into the record.

Mr. Arseneau: The part read into the record before is different.

Commissioner Lane: Proceed, Doctor.

Mr. Arseneau: It is the left-hand side of the page, the discussion by Mr. Haring.

The Witness: This discussion by Mr. Haring, who was [fol. 643] associated, as a matter of fact in charge of the Electrochemistry Lab at Bell Telephone Laboratories, says:

> "Congratulations are in order—to government agencies and manufacturers for the progress which has been made in battery development during the war years, and to the Chairman of this symposium for his success in promoting an extremely interesting program. I will take the liberty to express a few thoughts on batteries in general before commenting briefly on the paper by Messrs Mullen and Howard.
>
> "The electromotive force series contains only a limited number of metals, non-metals, and compounds which are physically, chemically and economically suitable for use as battery electrodes. Numerous investigators have attempted to develop new batteries from this abbreviated list. In consequence it is difficult to suggest a practical combination of electrodes which has not been used before and almost impossible to suggest an individual electrode which has not been at least considered. Electrode combinations are suggested, possibly patented, even used to a limited extent —and then forgotten. Frequently the same or similar combinations are re-discovered at some later date. A [fol. 644] recent survey of the literature indicates that, although more than a hundred combinations of electrodes and electrolytes have been proposed, con-

structed and tested as finished cells, only about half a dozen are in commercial use today."

Mr. Arseneau: I think that is far enough, Doctor.

If I may, I would like to refer you to Mr. Skrivanoff's patent, Defendant's Exhibit No. 19. I believe you were asked during cross-examination by Mr. Reilly to point to one or more references in the ones you discussed which showed magnesium and either a cuprous chloride or a silver chloride electrode, and after searching through your book you mentioned Defendant's Exhibit No. 19 as disclosing magnesium, on the one hand, and paste or a cuprous chloride constituent, on the other hand.

By Mr. Arseneau:

Q. I would like to ask you this, Doctor:

As to the use of water as the electrolyte in this cell, will you give the Court your opinion as to whether the terminal voltage or electromotive force would be developed?

A. I thing it would be quite likely.

Mr. Arseneau: I think that terminates our redirect examination, Your Honor.

Commissioner Lane: Any further questions?

Mr. Reilly: No questions, Your Honor.

[fol. 645] Commissioner Lane: You may step down, Doctor White. Thank you for your testimony.

(Witness excused.)

Commissioner Lane: Any further evidence from the defense?

Mr. Arseneau; No, sir.

Mr. Reilly: Your Honor, I would like to put Doctor Mantell back on for one or two questions.

Commissioner Lane: Mr. Arseneau, does that close the defense?

Mr. Arseneau: Yes, that closes the defense, Your Honor.

Commissioner Lane: Very well.

REBUTTAL TESTIMONY FOR PLAINTIFFS

WHEREUPON CHARLES L. MANTELL, a witness recalled on rebuttal, having been previously duly sworn by said Commissioner, was examined and testified further on behalf of the Plaintiffs, as follows:

Direct examination.

By Mr. Reilly:

Q. Doctor, did you test or put together the combination described in the Skrivanoff patent concerning the mixture shown on page 2?

A. A tried to put the mixture shown on page 2 of the [fol. 646] protochloride of copper, phosphorous, amorphous, phosphoric acid, and metallic copper, in spangles. It says that sulphuric acid has to be added to give the paste a sufficient consistency. I had two fire, and blew the side out of a vent. When I took the mix which was made and tried to make a battery, and then added the electrolyte on the other side, concentrated chromic acid, and then added potassium permanganate, I did not know what I had because it blew up.

Q. Referring to the Jumau patent, did you make a battery in accordance with Jumau?

A. What number is it?

Q. That is 2,078,143. Jumau disclosed lead chloride as an electrode and magnesium as the other electrode. I could read what the electrolyte was, but it included a magnesium salt. This was testified to by the Defendant's expert.

Did you make such a cell and test it?

A. I made such a cell and tested it, magnesium with lead chloride, and tried to use the lead chloride, and it was made in little slabs and rolled around the electrode to hold it is place, and that is what they say, and we used magnesium chloride as an electrolyte. The voltages and the currents were so small that we said it was inoperative and we could not make it generate any voltage.

Mr. Reilly: That is all. Your witness.

[fol. 647] Cross-examination

By Mr. Arseneau:

Q. I would like to ask several questions.

Doctor Mantell, do you think a researcher in studying the art would dismiss this in his mind as available technical knowledge in the public domain?

A. Would he dismiss it?

Q. If he reads the patent and fails to make any tests, would it impart no knowledge to him?

A. It might not be. We made every effort to do it.

Q. Do you think every literature researcher tests out for operativeness the system described in every reference which he discovers?

A. No, there is such a large amount of literature as to make it impossible.

Q. Do you think literature researchers would always construct equivalents to what they have found in the literature?

A. They certainly should.

Q. I understand that.

A. Yes, sir.

Mr. Arseneau: Your Honor, that concludes the cross-examination of Doctor Mantell.

Mr. Reilly: Thank you, Your Honor.

Commissioner Lane: The witness may be excused.

[fol. 648] (Witness excused.)

Mr. Reilly: I have no further witnesses to present, and so far as a closing statement is concerned, I think it would be presumptuous of me at this time to make a closing statement, since the Court is fully equipped to consider the matter.

Commissioner Lane: We will consider that the testimony is closed and requested findings of fact will be filed in accordance with Rule 45 (b) of the Rules of Practice.

Mr. Reilly: Thank you, Your Honor.

(Whereupon, at 5:45 o'clock p.m., Friday, July 14, 1961, the trial of the above-entitled cause was closed.)

* * * * * * * * * *

Reporter's Certificate to foregoing transcript omitted in printing.

[fol. 649] IN THE UNITED STATES COURT OF CLAIMS

TRIAL EXHIBIT NO. 2

Patented Apr. 21, 1953 2,636,060

UNITED STATES PATENT OFFICE

2,636,060

PRIMARY BATTERY AND METHOD OF MAKING THE SAME

Adolph Fischbach, Loch Arbour, and Hyman J. Mandel, Red Bank, N. J., assignors to the United States of America as represented by the Secretary of the Army

Application May 3, 1950, Serial No. 159,806

10 Claims. (Cl. 136—100)

(Granted under Title 35, U. S. Code (1952), sec. 266)

1

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment of any royalty thereon.

This invention relates to primary cells, of the deferred action type, using the electro-chemical system magnesium-water-cuprous chloride.

Magnesium-cuprous chloride batteries have attained considerable importance, particularly as "meteorological" or "one-shot" batteries, due to their high capacity per unit of weight and volume, their excellent operating characteristics even at low temperatures (linear potential and capacity), their ease of activation with water as electrolyte and their low cost of manufacture. Since neither acid nor alkaline electrolytes are used in these batteries, the danger of corrosion, cause *particuly* by acid fumes, is completely eliminated.

In the past, cuprous chloride electrodes were made from fused cuprous chloride. In manufacturing such cuprous chloride electrodes a supporting structure, for instance, a

coil or a wire grid, was placed in a mold and the latter supplied with the requisite amount of fused cuprous chloride poured from a heated crucible. It has also been known to dip a screen wire base into a fused mass of cuprous chloride in order to produce an adherent film on the screen. Fused cuprous chloride involves a number of severe production difficulties, particularly in mass production, due to the necessity of maintaining the cuprous chloride at relatively high temperatures while charging the supporting grids or plates with the fused cuprous chloride. In addition to these production difficulties, the active area of a fused cuprous chloride electrode is limited substantially to the outer surface exposed to the electrolyte while the interior parts of the fused cuprous chloride remain mostly inactive.

It is an object of this invention to produce a cuprous chloride electrode which is of a porous or spongy character. A further object is to facilitate manufacturing methods and to obviate the necessity of heating the cuprous chloride to the fused condition.

Briefly stated, the above-mentioned and other objects are attained by using, for the manufacture of the cuprous chloride electrodes, a pasty mixture comprising essentially finely ground cuprous chloride and a liquid, essentially water. The cuprous chloride is not brought into the fused condition, and heat, if any, is applied only to accelerate the drying process. The resulting cuprous chloride electrode is of porous, spongy character.

* * * * * * *

2

To improve the conductivity of the cuprous chloride, various inert conductive materials may be added to the pasty mixture, such as carbon black or graphite. Particularly suitable are the substances known under the trade names of "Dixon Graphite" and "Shawinigan Black." Such materials are preferably added in amounts of about 1 to 2% of the cuprous chloride.

* * * * * * *

[fol. 650] IN THE UNITED STATES COURT OF CLAIMS

TRIAL EXHIBIT No. 6

Reissued Oct. 5, 1954 Re. 23,883

UNITED STATES PATENT OFFICE

23,883

CUPROUS CHLORIDE ELECTRODES

Melvin F. Chubb, Joplin, Mo., assignor to the United States of America as represented by the Secretary of the Army

Original No. 2,658,935, dated November 10, 1953, Serial No. 204,134, January 3, 1951. Application for reissue March 12, 1954, Serial No. 415,997

10 Claims. (Cl. 136—100)

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

1

This invention relates to primary cells, of the deferred action type, using the electro-chemical system magnesium-water-cuprous chloride.

Magnesium-cuprous chloride batteries have attained considerable importance, particularly as "meteorological" or "one-shot" batteries, due to their high capacity per unit of weight and volume, their excellent operating characteristics even at low temperature (linear potential and capacity), their ease of activation with water as electrolyte and their low cost of manufacture. Since neither acid nor alkaline electrolytes are used in these batteries, the danger of corrosion, caused particularly by acid fumes is completely eliminated.

* * * * * * *

[fol. 651] IN THE UNITED STAT[illegible]COURT OF CLAIMS

TRIAL EXHIBIT No. 10

[fol. 651]

IN THE UNITED STATES COURT OF CLAIMS

TRIAL EXHIBIT No. 10

June 22, 1943. B. N. ADAMS 2,322,210

BATTERY

Filed Dec. 18, 1941

Fig. 1.

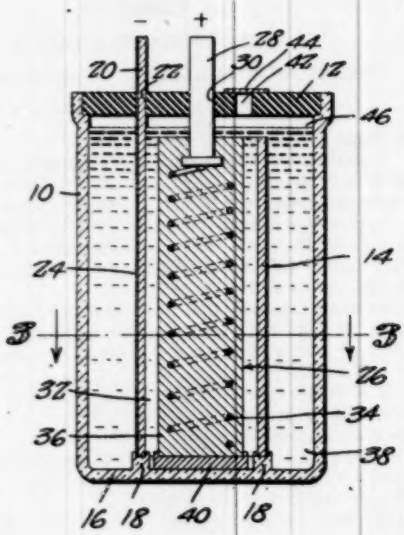


Fig. 2.

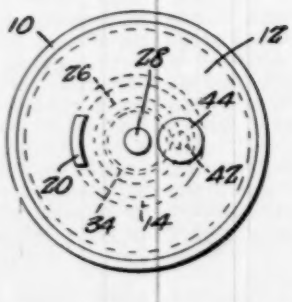
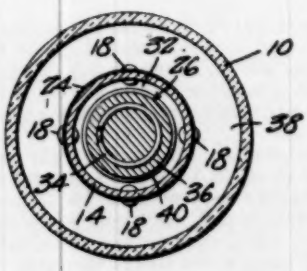


Fig. 3.



Bert N. Adams,
INVENTOR.

BY
Victor J. Evans & Co.
ATTORNEYS

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Patented June 22, 1943

2,322,210

UNITED STATES PATENT OFFICE

2,322,210

BATTERY

Bert N. Adams, Queens Village, N. Y.

Application December 18, 1941, Serial No. 423,548

11 Claims. (Cl. 136—100)

This invention relates to batteries.

An object of my invention is to provide a novel battery characterized by linear potential and capacity, wherein the battery is so designed as to eliminate acids such as are employed in conventional storage batteries, and in which the battery is of such a nature as to eliminate the release of dangerous fumes.

Another object is to provide a battery which is relatively light in weight with respect to capacity and in which the battery may be manufactured and distributed to the trade in a dry condition and rendered serviceable by merely filling the container with water.

In the accompanying drawing:

Figure 1 is a sectional view of a battery in accordance with my invention;

Figure 2 is a top plan view; and

Figure 3 is a sectional view taken along the line 3—3 of Figure 1.

In the embodiment selected for illustration, I make use of a container 10 provided with a closure or cover 12 of insulative material. The container 10 may comprise glass or any other material which is waterproof. Inside the container 10 is arranged an electro-positive electrode 14 comprising pure magnesium. The electro-positive electrode 14 is in the form of an open ended tube of a length slightly less than the height of the container 10. Projecting upwardly from the bottom 16 of the container are notched ears 18 in which the lower end of the electro-positive electrode 14 is supported. An extension 20 is provided at the upper end of the electro-positive electrode 14, which extension projects through an opening 22 in the cover 12 to constitute one terminal of the battery. The outer surface of the electro-positive electrode 14 is provided with a coating of tar 24.

Arranged concentrically within the electro-positive electrode 14 is an electro-negative electrode 26 in the form of a cylinder coextensive in length with the electro-positive electrode 14. Embedded in the upper end of the electro-negative electrode 26 is a copper terminal 28 extending through an opening 30 in the cover 12. The electronegative electrode 26 is of uniform diameter less than the inside diameter of the electropositive electrode 14 so as to provide a space 32 for the liquid contained in the battery. To the terminal 28 is connected one end of a copper coil 34 embedded in the core 36. The electropositive electrode 14 is of considerably smaller outside diameter than the inside diameter of the container 10 to provide a space 38 for the liquid, which space has communication with the space 32 at the bottom of the battery by reason of the ears 18 and also by reason of the fact that the electropositive electrode terminates short of the cover 12.

The body 36 of the electronegative electrode 26 comprises fused cuprous chloride (CuCL). In manufacturing the body 36, the coil 34 and the terminal 28 are arranged in a mold and the latter supplied with the requisite amount of cuprous chloride poured from a heated crucible. A piece of wood carbon is placed on the top of the cuprous chloride in the crucible and the latter is heated to a temperature ranging between 400° and 500° centigrade at which the cuprous chloride may be poured. The wood carbon constitutes a catalytic agent which renders the electronegative electrode 26 successful for the purpose intended, the exact chemical action being unknown to me.

After the electronegative electrode 36 is removed from the crucible, it is cooled and dipped in a 66° Baumé solution of sulphuric acid. While still dripping wet, the electrode 26 is covered with aluminium powder to prevent oxidation thereof. The electrode 26 is now ready for use.

The lower end of the electrode 26 is rested on a wood block 40 on the bottom 16. Both terminals 20 and 28 are firmly anchored in the cover 12 so that all the parts are maintained in fixed relationship when assembled with the container.

In designing the battery with respect to capacity, 25 square centimeters of electropositive surface is equal to 250 milliamperes. 2.8 grams of the body 36 of the electronegative electrode is equal to one ampere hour and one gram of the electropositive electrode equals one ampere hour. The outer face of the electropositive electrode is coated to confine the chemical action to its face adjacent the electronegative electrode 26.

For each 250 milliamperes of capacity, .3 gram of sulphate of magnesium is supplied to the container 10. Immediately upon supplying the container with the sulphate of magnesium, the filler and vent opening 42 is sealed by a closure 44. The vent opening may be closed by means of conventional seals of the type which embody a venting function but constitute a seal with respect to liquid. The container is maintained in a sealed condition until the battery is to be put into operation.

The battery is ready for use by merely filling with water, preferably to the level 46 slightly

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above the upper ends of the electrodes thereof. After filling with water, the battery is ready for use within thirty minutes. However, the battery may be made ready for instant use by supplying the container with one gram of chloride of magnesium in the form of a fused drop.

A battery in accordance with my invention is of relatively simple and durable construction and is exceedingly light in weight with respect to capacity. The battery is characterized by a linear potential and will operate successfully under all temperature conditions. Such a battery may be manufactured at a relatively low cost and is discarded when exhausted. In addition, there is no release of dangerous fumes or chlorine, the battery releasing hydrogen only. No metallic material is used for the container 10.

Without further elaboration, the foregoing will so fully illustrate my invention, that others may, by applying current knowledge, readily adapt the same for use under various conditions of service.

I claim:

1. A battery comprising a liquid container, a magnesium electropositive electrode inside the container and having an exterior terminal, a fused cuprous chloride electronegative electrode, and a terminal connected with said electronegative electrode.

2. A battery comprising a liquid container, a magnesium electropositive electrode inside the container and having an exterior terminal, a fused cuprous chloride electronegative electrode, and a copper terminal having one end embedded in said electronegative electrode.

3. A battery comprising a liquid container, a magnesium electropositive electrode inside the container and having an exterior terminal, a fused cuprous chloride electronegative electrode, a terminal connected with said electronegative electrode, and a liquid body comprising sulphate of magnesium and water bridging said electrodes.

4. A battery comprising a liquid container, a magensium electropositive electrode inside the container and having an exterior terminal, a fused cuprous chloride electronegative electrode, a terminal connected with said electronegative electrode, and a liquid body comprising sulphate of magnesium, water, and fused chloride of magnesium bridging said electrodes.

5. A battery comprising a liquid container, a tubular magnesium electropositive electrode inside the container and provided with a terminal, a fused cuprous chloride electronegative electrode in the form of a stick arranged inside the electropositive electrode in spaced relationship therewith, and a copper terminal having one end embedded in the electronegative electrode.

6. A battery comprising a liquid container, a tubular magnesium electropositive electrode inside the container and provided with a terminal, a fused cuprous chloride electronegative electrode in the form of a stick arranged inside the electropositive electrode in spaced relationship therewith, a copper terminal having one end embedded in the electronegative electrode, and a liquid body comprising sulphate of magnesium and water bridging said electrodes.

7. A battery comprising a liquid container, a tubular magnesium electropositive electrode inside the container and provided with a terminal, a fused cuprous chloride electronegative electrode in the form of a stick arranged inside the electropositive electrode in spaced relationship therewith, a copper terminal having one end embedded in the electronegative electrode, and a liquid body comprising sulphate of magnesium, water and fused chloride of magnesium bridging said electrodes.

8. A battery comprising a liquid container, a tubular magnesium electropositive electrode inside the container and provided with a terminal, a fused cuprous chloride electronegative electrode in the form of a stick arranged inside the electropositive electrode in spaced relationship therewith, a copper terminal having one end embedded in the electronegative electrode, and a protective coating on the outer surface of the electropositive electrode.

9. The invention described in claim 2 wherein there is provided a copper coil embedded in said electronegative electrode and connected with said copper terminal.

10. In a battery, the combination of a magnesium electropositive electrode, and an electronegative electrode comprising cuprous chloride fused with a carbon catalytic agent.

11. In a battery, the combination of a magnesium electropositive electrode, and an electronegative electrode comprising cuprous chloride fused with a wood carbon catalytic agent.

BERT N. ADAMS.

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[fol. 654] IN THE UNITED STATES COURT OF CLAIMS

TRIAL EXHIBIT No. 12

24 Apr. 57.

4. Dr. A. Fischbach, Nicholas Wilburn, and H. J. Mandel of USASEL, Power Sources Branch remember very well that they examined Mr. Adams' battery some time in the beginning of 1942. Their recollection is that the battery had an extremely high internal resistance and that the current density was very low because Adams' cuprous chloride was very unreactive. Besides, the electrolyte foamed out and the cells short-circuited very quickly. According to Dr. Fischbach, Mr. Adams was asked to continue the work on this system and resubmit samples if he could improve his battery. However, Mr. Adams did not return with any improved battery.

[fol. 655] 1/26

OCSigO 412.42 M-7-C-3

(Batteries Gen) January 14, 1942

Neutro Cell Storage Battery

Director, Signal Corps Laboratories, Fort Monmouth, Red Bank, New Jersey

1. Attention is invited to the attached letter from John J. Sandhaas of Waud & Doherty, 25 West 43rd Street, New York, New York, dated January 10, 1942, to this office, with four inclosures. Particular attention is invited to Inclosure No. 3, "Characteristics of Neutro Cell," wherein it is pointed out that this cell works at both extremes of temperature and has been tested at forty degrees (40°) F below zero, and at two hundred degrees (200°) F. above zero.

2. Your comments and recommendations regarding the application of the Neutro Cell to your Laboratories development project on batteries for low temperature operation, and the application of the Neutro Cell to Signal Corps equipment, are desired by indorsement hereon.

3. In the event your Laboratories desire to witness a demonstration of the Neutro Cell, or to procure samples for test, you are authorized to communicate directly with Mr. John J. Sandhaas and arrange a demonstration if practicable.

4. The return of all inclosures is desired.

By order of the Chief Signal Officer:
J. D. O'Connell, Lieutenant Colonel, Signal Corps.

1 Encl.
Le fm John J. Sandhaas, dated 1-10-42, to CSO, w/4 Incls.

(1st Ind. on next page)

File Folder S-27:1 X, By M. Date 1-29-42.

[fol. 656]

FM(SCL)Prof. 8-27.1 CRK:GBE:m
OCSigO 412-42 (Batteries Gen)
1-14-42) 17389 FI 42

1st Ind.

Signal Corps Laboratories, Fort Monmouth, Red Bank, N.J. January 29, 1942.

To: Chief Signal Officer M-7-C-3, War Department, Washington, D.C.

1. With reference to paragraph 2 of the basic communication, it is difficult to make any recommendations until tests have been conducted on the neutro cell storage battery.

2. Mr. Bert Adams, the inventor, visited these Laboratories on January 26, 1942 and left a sample for examination and test. It is contemplated that tests will be completed in two weeks time after which a report will be prepared and forwarded to your office.

For the Directors:
Oscar C. Maier, Lieut. Colonel, Signal Corps.
Incl. 1 n/c

File Folder S-27.1 X, By M. Date 1-29-42.

[fol. 657] CRK:GBY:AIDig

FM(SCL) Proj. S-27.1

February 5, 1942.

Mr. Bert Nemo Adams
215-10 111 Rd.
Queens Village, N. Y.

Dear Mr. Adams:

If you have two (2) completed Neutro Cells in your possession, it is suggested that you send them to these Laboratories for further test.

These samples should be sent prepaid at no expense to the Government as required by regulations.

Very truly yours, Clarence R. Kingston, Captain, Signal Corps, Asst. OC, Field Laboratory No. 2

File Folder S 27.1 X, By g. Date 2/5/42.

[fol. 658] February 7, 1942.

Mr. John J. Sandhaas
Waud & Doherty
25 West 43rd Street
New York City, N.Y.

In reply refer to: No. 38610

Dear Mr. Sandhaas:

The Engineering Staff of the National Inventors Council has made a preliminary examination of the material submitted with your letter of January 7 addressed to Dr. Kettering. However, the material lacks the necessary details required for a complete evaluation.

We would appreciate receiving a complete description stating all the chemical reactions which take place in the battery, in order that we may bring it to the attention of the proper authorities.

We are enclosing a copy of our Information Bulletin No. 2 which explains our procedure in handling inventions.

Very truly yours, J. C. Green, Assistant Chief Engineer

Enclosure

LSH/JCG/mch

[fol. 659] April 8, 1942.

Mr. John J. Sandhaas
Waud & Doherty
25 West 43rd Street
New York, N.Y.

In reply refer to: No. 38610

Dear Mr. Sandhaas:

The additional information contained in your letter of March 28, 1942, has been attached to your previous file and will be brought to the attention of our Technical Staff. You will be advised of their findings within a few weeks.

Please accept our thanks for the cooperation shown in making this information available.

Very truly yours, J. C. Green, Assistant Chief Engineer

JCG/meb

[fol. 660] April 18, 1942.

Mr. John J. Sandhaas
Waud & Doherty
25 West 43rd Street
New York, N.Y.

In reply refer to: 38610

Dear Mr. Sandhaas:

The technical staff of this Council has examined your proposal relating to a neutro cell and has recommended its transmission to appropriate authorities for more intensive

consideration. This office will advise you as to their decision as soon as complete information becomes available.

You may wish to consider sending a copy of your proposal to the Vice Chairman of the British Inventions Board at 15 Broad Street, New York City, subject to any prohibitions as to secrecy which may exist relative to your invention.

Your interest and cooperation in the war effort are appreciated at this office and it is hoped that you will continue to furnish us such suggestions as appear to you to be of value in the present emergency.

Very truly yours, J. C. Green, Assistant Chief Engineer.

JCG/akm

[fol. 661] December 16, 1942.

MEMORANDUM

To: Col. Lent

From: Mr. McBurney

Subject: Storage battery.,
#38610,
John J. Sandhaas.

Dr. Vinal of the NBS comments as follows:

"Letter from the Bureau of Ships to the Secretary's Office, dated September 11, 1942, signed by Lt. O'Brien, says Signal Corps has made a complete test of subject cell and finds it is not consistent in operation. The Signal Corps is quoted as not giving it further consideration and for this reason the Bureau of Ships does not care to consider it further.

"The same cell was brought to the attention of the Bureau of Ordnance (Navy) and verbally I have learned that it is not being considered there.

"Inventor's claims of operation at —40° when activated with water alone is untenable unless cell is filled at temperatures above freezing.

"Letter of Bert Adams to Capt. Kingston, dated March

25 (and other papers), give certain data about the cell from which it appears:

"(1) The internal resistance is relatively high as shown by a drop in voltage of 0.2 volt when load of 25° milliamperes is applied.

"(2) Reasons for specifying the maximum safe load as 300 milliamperes are not clearly understood but indicate that this cell may be of a type which "runs away" as a [fol. 662] result of local action when over-taxed. However, the inventor's statement and this interpretation seem to be inconsistent with his next statement that the maximum current on "dead short" is "1.8 amperes until spent".

"(3) Data given in this letter indicate a high watt hour output per unit of weight which is favorable to the battery, but it is felt that some more definite test data should be given to support what appear to be unusually large claims.

"(4) In discussion of the cell there is no point in saying that it is "based on a new kind of electro-chemical action". Reserve type cells of one kind or another have been known for years.

"(5) The claim is made that the cell has indefinite shelf life, presumably because it is dry, but the author acknowledges that damp air, if accessible, would speedily render it useless.

"(6) The statement that this is the only primary cell which does not contain any acids, alkaline or other caustics as electrolyte is nonsense. The ordinary dry cell is a primary cell which does not contain acids, alkaline or other caustics as electrolyte.

"(7) Magnesium is an important material now and probably not available.

"(8) The graphs submitted by the inventor are far from convincing to me. They are drawn with a ruler. There is no indication of the various observations which were presumably taken. The time scale jumps from seconds to minutes to hours. The general impression conveyed by these graphs is that the person who drew them was not familiar with recognized methods of presenting technical data.

"(9) Until the inventor can present more convincing data about the performance of his cell, I see no reason to consider it further. If it is of any use, much development would be needed."

J. W. McBurney, Bureau of Standards

JWMcB/hmp

[fol. 663] March 24, 1943.

Mr. John J. Sandhaas
Waud & Doherty
25 West 43rd Street
New York, New York

Dear Mr. Sandhaas:

In checking through our old files, I find that your proposal relating to the "neutro cell" was submitted to a number of Government branches, but we were unable to obtain any positive expression of interest. I was wondering if subsequent developments with regard to your unit might alter the picture.

Accordingly, we would appreciate some information as to the present status of the battery.

Very truly yours, J. C. Green, Assistant Chief Engineer.

JCG/eb

[fol. 664] September 2, 1943.

Mr. Burt N. Adams
215-10 111th Road
Queens Village
New York, New York

Dear Mr. Adams:

The War Production Board has approved the use of ten pounds of magnesium sheets. See attached copy of their letter on this matter. We are also returning herewith the priority forms you submitted, since it appears that you can fill your order in New York.

It is hoped that you will now have no difficulty in obtaining the necessary material. This office would be pleased to be kept advised of the results of tests of your battery and any interest therein which may arise.

Yours very truly, J. C. Green, Assistant Chief Engineer

JCG/ads
Enclosures

[fol. 665] Magnesium - Cuprous Chloride Cell

Introduction:—

A Magnesium-Cuprous Chloride battery was patented by B. N. Adams - U.S. Patent #2,322,210, June 22, 1943. The advantages claimed are:

1. Linear potential and capacity.
2. Eliminates acid as the electrolyte and hence the evolution of dangerous fumes is avoided.
3. The battery is manufactured and distributed in a dry state and is rendered serviceable by merely adding water. Thus, so long as the cell is kept in the dry state, its shelf-life can be indefinitely prolonged.
4. 25 sq. cms of electropositive material (magnesium)

is equal to 250 milliamperes. 2.8 gms of electro-negative material (Cu_2Cl_2) is equal to one ampere-hour and one gram of the electro positive electrode is equal to one ampere-hour.

5. The battery is therefore light in weight with respect to capacity, relatively cheap to manufacture and is discarded when exhausted.

Discussion:—

A cell was made on the general principles as laid down by the inventor. No attempt was made at this time to determine the quantitative amounts of either the positive or negative electrodes. The purpose now was spec whether a battery so devised can be made without too much difficulty and a working voltage and amperage obtained.

For the container; an electrolytic beaker of 250 ml capacity was taken. The positive electrode consisted of pure magnesium one side of which was cleaned with dilute acid. The sheet was approximately 9 x 15 cm. sq. It was rolled into a cylinder, the diameter of which was slightly smaller than that of the container. The negative electrode was made by heating Cu_2Cl_2 at about 450°C until liquid and then poured into as a mold. The electrode then formed was approximately 1.7 cm diameter and 10 cm long. It is dipped into concentrated H_2SO_4 and while still wet covered with a thin layer of Aluminium powder. This inhibits the oxidation of the Cu_2Cl_2. Embedded in the upper end of the negative electrode is a copper wire coil and copper terminal.

Date Nov. 26, 1943
over
Signal Corps Laboratories

Signature William Shorr.

Item 21
TX-12, page 17

[fol. 666] The negative electrode was arranged within the center of the positive electrode composed of the cylinder of magnesium. A cover was placed over the container through which extended the positive and negative terminals. Another small hole was drilled through the cover for the purpose of filling the battery when ready for service. The cover was then sealed to the glass container by means of wax.

The battery was filled to within about 1/4 in. from the top with water and allowed activation for a few minutes, after which the voltage was taken. The initial voltage was 0.90 volts. A little magnesium sulfate was added to counteract polarization about the positive electrode and the voltage again taken. It showed 1.20 volts. Solid $MgSO_4$ was added until no further increase in voltage occurred on addition. The maximum voltage obtained was 1.46 volts. After 20 hours, the voltage was 1.40 volts.

The short-circuited amperage slowly built up to 500 milliamperes. After 2 hrs., 1 amp was reached. When the voltage was taken immediately thereafter, it showed 1.6 volts which slowly fell back to 1.46 volts. This procedure was repeated several times with the same results.

The decomposition materials were voluminous and tended to adhere to the electrodes causing a voltage drop. It was necessary at times, to remove them by agitating the electrodes.

Conclusion:—

The battery is feasible. It can be easily constructed and maintained provided the internal resistance of the water electrolyte is partly overcome.

The battery is not immediately activated on the addition of water, beginning about 15 minutes or more. Can activation be induced immediately?

Once activated, the battery continues active until exhausted. Can the reaction be inhibited or stopped when the cell is not in use?

Date 11/26/43
Project

Signature Wm. Shorr.

Signal Corps Laboratories

[fol. 667] IN THE UNITED STATES COURT OF CLAIMS

TRIAL EXHIBIT No. 13 (a)

THE NATIONAL INVENTORS COUNCIL

Department of Commerce Building
Room 7422
Washington, D. C.

Information Bulletin No. 1
Revised—March 1941

[fol. 668] THE NATIONAL INVENTORS COUNCIL
Department of Commerce Building
Washington, D. C.

Information Bulletin No. 1
(Revised)

The National Inventors Council has been created by the Secretary of Commerce, with the concurrence of the President of the United States, to aid the military and naval branches of the Government by bringing to their attention all such discoveries and mechanisms as appear to have defensive value. The Council is comprised of outstanding American inventors, scientists, and businessmen having wide experience in the development and utilization of inventions.

* * * * * * *

All suggestions are held confidential by the Council and will not be disclosed to any unauthorized persons.

* * * * * * *

[fol. 669] 8

It is not necessary to engage the services of an attorney to present an invention or suggestion to the Council.

[fol. 670] 9

The Council has no authority to consider the question of compensation for the use of a suggestion or invention by any Government Department or agency. Should an invention be utilized, the matter of compensation will be referred to the Executive Department of the Government making use of the product embodying the invention. Final settlement for the acquirement of rights can then be arranged between the inventor and the appropriate official of the Department making the purchase.

The amount of compensation can be considered only after tender of the suggestion or invention, and its adoption by an executive branch of the Government. The creation of the Council does not in any way affect the existing laws or practices of the Government Departments as to compensation.

* * * * * * *

[fol. 671] IN THE UNITED STATES COURT OF CLAIMS

TRIAL EXHIBIT No. 13 (b)

U. S. DEPARTMENT OF COMMERCE
JESSE H. JONES, *Secretary*

National Inventors Council
CHARLES F. KETTERING, *Chairman*

HOW INVENTORS CAN AID THE WAR EFFORT

Information Bulletin No. 2
(Revised 1942)

For Inventors, Engineers, Scientists
Technicians and Others
Desirous of Aiding the War Effort

U. S. Government Printing Office: 1942

• • • • • • •

[fol. 672] Purpose of the Council

* * * * * * *

The Council's primary functions are:

(1) Encouraging the public to submit inventions or inventive ideas of value in the war effort.

(2) Prompt evaluation of these inventions by a staff of engineers and by a system of technical committees so that useful ideas may be promptly placed in the hands of the proper military and naval bureaus.

It is also thought that a central file of suggested inventions will be of very considerable continuing value.

In sixteen months of operation, the Council received approximately 90,000 communications, of which about 55,000 contained inventions or inventive ideas. A surprisingly [fol. 673] large percentage of these have possessed sufficient merit to warrant serious consideration. A number already have been accepted for use by the Army, the Navy, and other Government agencies.

* * * * * * *

Each invention, suggestion, or idea received is acknowledged, then classified and referred to one or more staff engineers for careful examination and evaluation insofar as concerns its possible value to the war effort. Those appearing meritorious are then referred to the appropriate Technical Committee Chairman [1] for his consideration and report. When the Chairman believes an invention to be of value, it is referred to the Council as a whole. If the Council affirms the Chairman's opinion and recommends the invention, it is then forwarded to the Army or Navy, or both, for their consideration, and ultimate adoption if they find it acceptable. In such event, the appropriate departments of the Army and Navy then deal directly with [fol. 674] the inventor in making the necessary arrangements for the use of the invention. The Council itself does not consider the question of compensation or contracts

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[1] See appendix for list of technical committees.

between inventors and the Army or Navy. The negotiation of such contracts is conducted by the appropriate Military and Naval authorities.

* * * * * * *

CHARACTER OF USEFUL INVENTIONS

* * * * * * *

[fol. 675] However, it should be encouraging to the prospective inventor to know that many of our most useful items of military equipment have been devised and developed by civilians, in some cases by those who have had no experience in military affairs. Well-known examples include the airplane, the machine gun, smokeless powder, and rifled cannons.

In the past, many ideas, originated by civilians, have been brought to a state of important usefulness through the assistance of the well-equipped engineering bureaus of the Army and Navy. No inventor should refrain from offering any device which in his opinion represents a real advance in the art, or meets an urgent military or naval need.

* * * * * * *

[fol. 676] WAR VALUE OF INVENTIONS

* * * * * * *

The National Inventors Council will give full and sympathetic consideration to every idea submitted to it. It will see that every meritorious idea is brought to the attention of every agency which might find such an idea useful.

It would seem to be the privilege and indeed the patriotic duty of the inventive minds of our country to transmit the results of their creative thought to that government agency charged with the duty of making them useful in this time of national emergency—The National Inventors Council.

* * * * * * *

[fol. 677] SUGGESTED PROCEDURE FOR SUBMITTING INVENTIONS

* * * * * * *

[fol. 678] All suggestions are held confidential by the Council and will not be disclosed to any unauthorized persons.

* * * * * * *

[fol. 679] IN THE UNITED STATES COURT OF CLAIMS

BERT N. ADAMS, et al., Plaintiffs,

vs.

THE UNITED STATES, Defendant

FURTHER STIPULATION

1. The parties stipulated that each of the documents offered and received in evidence without objection as Trial Exhibit 15, filed herewith, which documents were originally received by plaintiffs from Lieutenant Colonel Willard J. Hodges, Jr., JAGC under a covering letter dated March 1, 1960, (copy also filed herewith as part of Trial Exhibit 15) is an accurate copy of a genuine original and if the document is a letter, it is further stipulated that such was written by or for the person, department or organization whose name or identification appears thereon as the author thereof; and was sent to and received by the person, department or organization indicated thereon as the addressee thereof, on or about the date appearing on the document.

The parties stipulated that if Bert N. Adams were called as a witness in this suit to testify with respect to the documents which were offered and received in evidence without objection as Trial Exhibit 16, Group 3 filed herewith, he would testify:

As to said documents in Group 3 of Trial Exhibit 16, which are handwritten or typewritten notes, they are the genuine notes or accurate copies of the genuine notes of Bert N. Adams as follows:

[fol. 680] Page 1 thereof is Mr. Adams' notes recording his trip to Washington to visit at the Navy Department from January 21, 1942 through January 24, 1942, and his trip to The Army Signal Corps. Laboratories at Ft. Monmouth on January 26, 1942 where he left one battery cell.

That pages 2 and 3 thereof, which carry no dates thereon, are Mr. Adams' pocket notebook entries recording the names of some of the people he saw at the Navy Department from January 21, 1942 through January 24, 1942 and at Ft. Monmouth on January 26, 1942.

Page 4 thereof is Mr. Adams' notes recording a trip to Ft. Monmouth on March 13, 1942 and another trip thereon March 26, 1942 when he delivered ten battery cells.

Page 5 thereof is Mr. Adams' notes recording a trip to Ft. Monmouth on January 11, 1943.

Page 6 thereof is Mr. Adams' notes recording a trip to Ft. Monmouth on January 30, 1943 and another on July 10, 1943.

[fol. 681] Page 7 thereof is Mr. Adams' notes recording a trip to Ft. Monmouth on June 22, 1948.

John A. Reilly, Attorneys for Plaintiffs, 165 Broadway, New York 6, N. Y.

Dated: June 30, 1961

William H. Orrick, Jr., H&B, Assistant Attorney General.

Dated: July 6, 1961

Paul F. Arseneau, Attorney, Dept. of Justice.

Dated: July 6, 1961

[fol. 682] IN THE UNITED STATES COURT OF CLAIMS

TRIAL EXHIBIT No. 15

WAUD & DOHERTY
Accountants and Auditors
154 Nassau Street
New York

January 7, 1943.

Mr. Charles F. Kettering, Chairman
National Inventors Council,
General Motors Research Co.,
Detroit, Michigan.

Dear Sir:

We have been referred to you by the Federal Regional Information office located at 122 East 42nd Street, New York City, as the proper person to whom the following facts should be presented.

A client of ours has perfected a new and unique means of developing electric current known as the "Neutro Cell", patent for which has recently been applied for. Statements of the characteristics and possible uses of this cell are enclosed herewith, together with graphs showing the result ... tests made by our client and supported by tests made ... the laboratory of the National Carbon Co., at Cleveland, Ohio by their chief Chemist.

It's uses for defense purposes are invaluable considering that it will furnish light and power under such conditions as on a sinking ship, airplane, or institution where the regular power has failed.

The inventor has three of these cells left for further tests but because its manufacture requires the essential metal of magnesium, he has been unable to obtain this raw material for continued manufacture.

He has expressed his willingness to demonstrate the efficiency of this cell and would appreciate hearing from you as to what steps are to be taken to present this demonstration before the proper defense authorities.

Your advice in this matter would be greatly appreciated.

Very truly yours, John J. Sandhaas.

[fol. 683] CHARACTERISTICS OF NEUTRO CELL

This cell is based on a new type of electrochemical action. It can be stored indefinitely without alteration or loss of power until the moment it is used

Volts:	1.6
Capacity:	For every 3 tray ounces of cell weight (exclusive of container weight) the capacity is 500 milli-amperes continuous drain for 16 consecutive hours.
Can higher amperage be obtained:	Yes—any amperage can be obtained. The amperage can be reduced or augmented in ratio to the square surface of the electrodes or cell plates.
What is the potential curve?	Linear and constant with no load or with full load up to full capacity of cell.
What potential drop has cell under load?	10% under full load and then linear until spent.
What capacity drop under load?	None—linear until spent.
Life of cell:	Indefinite until activated by the addition of 25 c.c. of water for each 500 mills. capacity.
Is electrolyte used?	No—no acids, alkalines or any other liquid other than plain water is used in this cell. Water does not have to be distilled.
Are dangerous fumes or gases emitted before, during or after activation?	No. The only gas emitted is hydrogen in negligible amounts and the only residue left are insuluble oxides. This cell does NOT contain Bioxide of Magnesium as di-polarizing agent and will not emit Chlorine Gas if salt water is used to activate it—in fact salt water can be used in activating it. This factor makes it of special value and safety as an auxiliary source of power for Submarines.

Does polarization take place upon rapid discharge?	No. Owing to this fact the potential remains linear until spent.
Can this cell be short circuit?	Yes, without any harm other than the normal consumation of current for the duration of short, i.e.: If a cell manufactured to give 1 ampere of continuous current for 10 hours should be short circuit for one hour and the short then removed there would be instantly available 1 ampere of continuous current for the remaining 9 hours.
Will cell work at both extremes of temperature?	It has been tested at 40 F. below and at 200 F. above 0.

[fol. 684] Some possible uses of the NEUTRO CELL

1

Emergency source of light and power on Submarines, warships, etc. Age does not alter the power of cell. No danger of chlorine gas emissions upon contact of salt water.

2

Source of light for miners lamp: it would replace the present heavy and dangerous costly battery. A one pound unit will give 5 watts continuous for 10 hrs. and is from 5 to 6 lbs. lighter than the battery currently used without the danger of alkaline burns to the men using it.

3

Source of light for: bomb shelters, Army and Navy emergency light source. Standard Army tent light (the cost of manufacture is very cheap and the cell can be stored indefinitely.)

4

Filament current for Army portable radio transmitters. This use is very important when we consider that the common dry cell must be kept away from dampness and

cannot be stored indefinitely. This cell owing to its linear output would eliminate much of the fading due to low filament current. The transmitting tubes need not be of high potential filament but can be made with a heavy filament of low potential and higher drain in amperes. The above applies also to receivers.

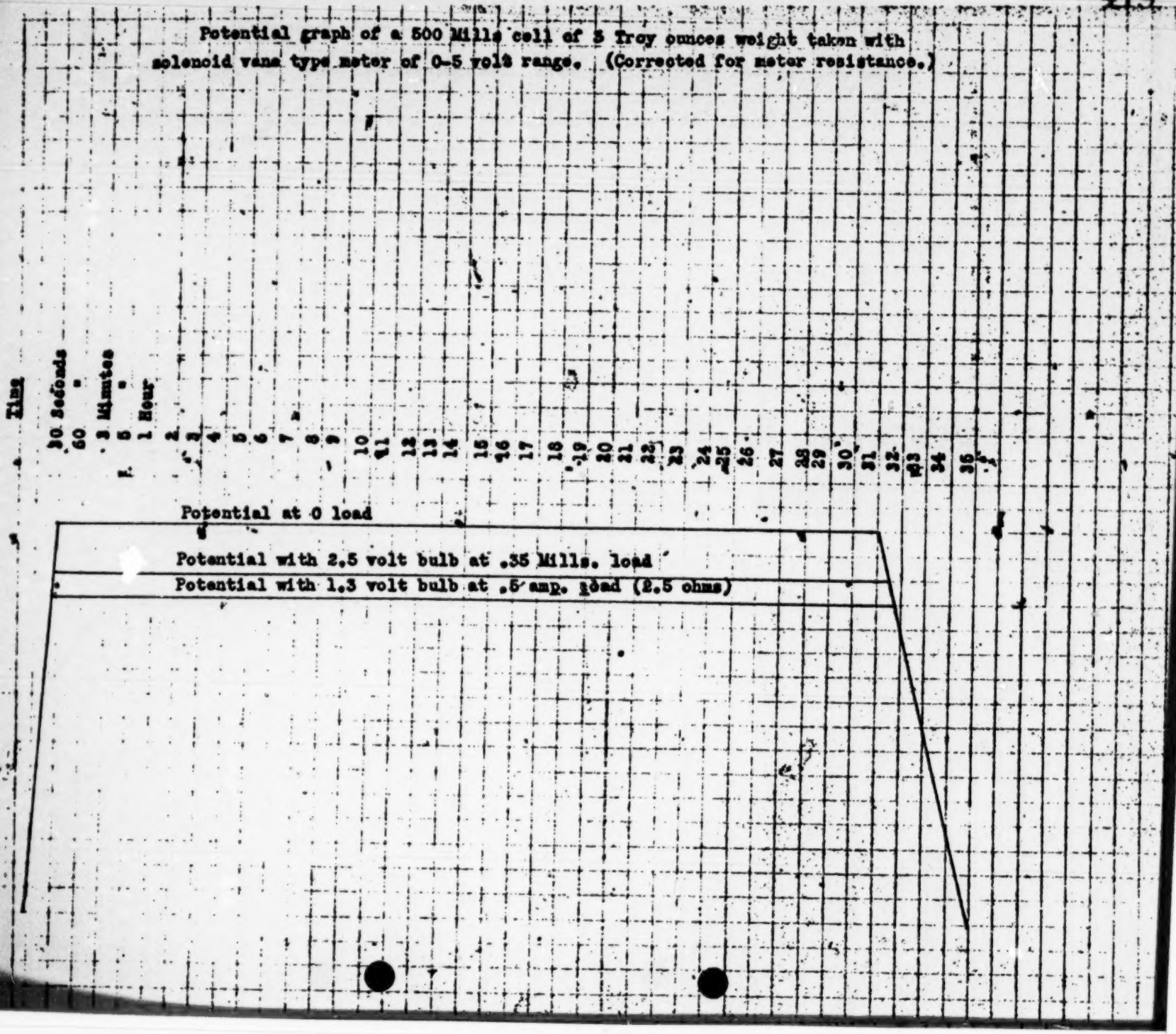
5

Source of emergency power for airplanes: The weight is much less than the present storage battery and with this cell the generator can be eliminated from the ship. In this case this cell can deliver light and spark power for the duration of flight.

6

As this cell can be manufactured in any shape or contour it can easily be made to fit the most remote places.

Potential graph of a 500 Mills cell of 3 Troy ounces weight taken with solenoid vane type meter of 0-5 volt range. (Corrected for meter resistance.)



[86]

Capacity graph of a 500 milliampere cell of 3 troy ounces weight taken with solenoid vane type meter & the Kalb. with added resistance in series

30 Seconds
60
1 Minute
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35

500
450
400
350
300
250
200
150
100
50
0

[fol. 687] March 25, 1942.

Capt. C. Kingston,
U. S. Signal Corps. Labratories,
Fort Monmouth, N. J.
Att. Authomotive and Power Section, Low Temperature Group. Refer to FM (SCL) Project S-27.1

Dear Sir:

The following are the specifications of the cells I am submitting as per your request of March 13, 1942.

Volts: 1.6 open circuit.
Volts: 1.4 when fully activated with 250 milliamperes continuous drain.
Maximum safe drain in milliamperes: 300 (will heat about 300 mill's. drain).
Maximum current on dead short and 0 volts: 1.8 ampere until spent.
Ampere hours: 2.5
Watts: .4 at drain of 250 milliamperes.
Height: from bottom to top of terminals—7.5 centimeters.
Diameter: approximately 3 centimeters.
Weight: unactivated—35 grams.
Weight: activated with 25 c.c. of water 60 grams.
Average internal temperature: 84 F. (taken at room temp. of 75 F.)

These sample neutro cells are made exceptionally small to meet your specified requirements, although they perform more efficiently if made in larger sizes. Owing to technical reasons, they cannot be made smaller than the samples submitted herewith.

It will be noted on testing that the potential will remain linear until cell is spent. The main scope of these sample cells is to present a new principle of electrochemical type of lightweight high capacity linear potential electric cell which contains no caustic potash, soda or acids, and which does not emit dangerous gases.

This cell can be activated with sea water, as no chlorine is formed when sodium chloride is added.

We await the results of the tests.

Very truly yours, Bert Adams, 215-10 — 111th Road, Queens Village, L. I. N. Y.

[fol. 688] (Copied from an illegible document received from the Government.)

WAUD & DOHERTY
Accountants and Auditors
25 West 43rd Street

New York, March 28, 1942.

Department of Commerce,
The National Inventor's Council,
Washington, D. C.

Re: No. 38610

Gentlemen:—

In reply to your letter of February 7th, we enclose herewith additional data as prepared by Mr. Bert Adams, inventor of the Neutro Cell.

The delay in our reply was due in part to further tests and experiments necessary to comply with the request of Captain C. Kingston, U.S. Signal Corps, Fort Monmouth, N. J. for undersize samples especially adapted for use under extremely low temperature conditions. Copy of letter giving specifications of these samples is enclosed herewith.

We shall be glad to answer any technical questions you may wish to submit and Mr. Adams will be available at any time to submit samples and give tests at your laboratory to demonstrate the effectiveness of his cell.

Your interest and cooperation in this matter is greatly appreciated.

Very truly yours, John J. Sandhaas.

jjs/ep
encl.

[fol. 689] APPLICATIONS OF THE ADAMS NEUTRO CELL

Miner's Lamp: The present universal miner's lamp contains nickel and steel elements and uses potassium hydroxide (caustic potash) as electrolyte. This battery weighs from 7 to 10 pounds according to the model. The maximum capacity is 13 ampere hours for a perfect fully charged battery. It is a storage battery and consequently must be charged like all storage batteries with the addition that the electrolyte must often be changed and greater care must be exercised in charging than with the ordinary type of acid cells.

An Adams cell equivalent in capacity to the above battery weighs complete with water, only 1 pound. Uses plain water as electrolyte.

Advantages of Adams Cell: No alkaline electrolyte to burn the miner or cause severe damage to clothing and equipment. It is 6/7 to 9/10ths lighter in weight than the battery now in use. No charging lamp house and costly equipment needed. Battery is discarded after spent. No worry about fading or dimming light due to old, deteriorated or improperly charged batteries, as often happens to all storage type cells. The Adams battery is the miner's lamp of tomorrow.

Army Field Radio Receivers and Transmitters: All Army field receivers and transmitters working from a 6 volt storage battery for filament and B potential through the means of suitable transformer and vibrator would have the great advantage over the storage battery, in so far

as the Adams Cell does not need charging and can be stored indefinitely, and carried about under the most difficult conditions. The weight of a unit at 6 volts capable of delivering 24 watts continuously for 12 hours is approximately 2 lbs. The unit would lead the modern field and parachute troop transceivers, which are capable of sending phone messages within an area of about 20 miles. The bulk of a unit as described would be approximately 4 x 4 x 10 inches (160 cubic inches).

Bomb Shelter and Other Emergency Light Source: The bomb shelter light is a small container 1¾ inches in diameter by 3 inches in height. The bulb is a 1.3 volt draining 650 milliamperes. (Mazda) This light will burn without dimming for a period of 12 consecutive hours. The total weight, fully activated with water, is only 240 grams. Net weight 165 grams.

Army & Navy Emergency Source of Light and Power: This light source can be manufactured in any size or shape desired, to fit the particular need. Since it

[fol. 690]

does not contain acid or caustic electrolyte, there is no danger of severe burns or other damage through breakage or spilling. All other primary cells use either acid or caustics which must be stored in separate containers ready to use or activated. These containers, therefore, cannot be roughly handled without danger.

Aeroplane Applications: These batteries can be used in all types of ships where weight and space demands consideration. The cells can be manufactured to last for the duration of any flight and re-

placed at the field when loading with gas, oil, etc. Their use would eliminate the generator and the troubles arising from corrosion.

Submarine Application: This cell can be activated with sea water without emitting chlorine gas, Therefore, an emergency load of these cells in any submarine would be of tremendous advantage in certain cases of disaster. Temporary operating power can be obtained from them.

Ships, Boats, etc.: Their use as light source would eliminate the danger of fire on small boats not electrically equipped for long periods of light source. Can be used to replace oil running lights, and especially suitable for emergency anchor light in heavy weather. Emergency Light Source in any beat in the event of power failure.

[fol. 691] THE ADAMS NEUTRO CELL

This primary self generating electric cell is based upon a new kind of Electrochemical Action. It is manufactured dry and may be stored indefinitely until the moment it is used. The cell is activated by simply adding plain water through a filler hole on the top of the cell container.

This filler hole also acts as the necessary vent for the escape of the excess hydrogen generated in the cell when activated, and must remain sealed until the cell is used otherwise the damp air would cause the rapid oxidizing of the elements and render it useless.

The average electromotive force (potential) is 1.6 volts. The potential remaining linear until the cell is spent. The potential drop is approximately 10% with full drain as recommended on each unit. If you desire to test the potential at closed or open circuit, a vacuum tube volt meter is recommended, unless the exact internal resistance of the motor used is known so as to make the proper correction.

The cathode (negative element) is a flat or round plate

of magnesium and the anode (positive element) is made of copper fused in a special manner.

Since the electrolyte is plain water, the container may be manufactured either of waterproofed paper or fibre, very thin plastic or tin. It is not necessary to use a hard acid proof rubber container, as there is no corrosion.

This is a constant load cell and is not designed to intermitant service.

The weight in comparison to the capacity is approximately [fol. 692] as follows: a cell of 1.6 volts manufactured to deliver 2 amperes constantly for a period of 12 hours (3.2 watts each hour) will weigh approximately 400 grams including the water.

The bulk of such unit is approximately 1176 cubic centimeters—(14 x 14 x 6 centimeters.) In inches it would be about 5½ x 3½ x 2¼.

This cell can be manufactured to give current from 100 milliamperes to 100 amperes per cell. The potential, irrespective of the current capacity of the cell is always 1.3 volts per cell.

Two cells in series would naturally give 3.2 volts etc. When activated this cell will not emit dangerous gas or other odors, the only gas emitted being a slight amount of hydrogen.

This is the only primary cell which does not contain any acids, alkaline or other caustics as electrolyth.

[fol. 693]

WAUD & DOHERTY
Accountants and Auditors
154 Nassau Street
New York

June 4, 1943

Department of Commerce,
National Inventor's Council
Washington, D. C.

Att: Mr. J. C. Green

Gentlemen:

We regret that this reply to your letters of April 29th and March 24th was so long delayed but Mr. Adams, inventor of the Neutro Cell, has been engaged in defense work and not available until yesterday.

The patent on his battery has been approved for issue June 22nd, number 2,322,210 and contains certain improvements.

Many samples have been submitted to the Army Signal Corps at Fort Monmouth, N. J. for tests under extreme hot and cold temperatures, the final results of which we still await. No other branch of the armed services has shown any interest.

The inventor is handicapped by lack of materials, and cannot even obtain replacements of materials for samples submitted to the Signal Corps. It would be very helpful if your office could furnish priority rating or other authority for us to purchase ten pounds of magnesium which would permit manufacture and further experiment of several dozen cells.

Mr. Adams would welcome an opportunity to demonstrate the possibilities of his cell at his laboratory to an electrical engineer from your department.

Very truly yours, John J. Sandhaas.

JJS:MN

Please note change of address.

[fol. 694] IN THE UNITED STATES COURT OF CLAIMS

TRIAL EXHIBIT No. 16

* * * * * * *

June Trip to Squires Labs at Ft. Monmouth. Low Temp. Labs. Talked to Dr. Payne, Mr. Daniels & Dr. Fishback & Mr. Ellis trip costs & dinner..... 10.50
left one sample for test

$27.32

* * * * * * *

[fol. 695] IN THE UNITED STATES COURT OF CLAIMS

No. 163-60

BERT N. ADAMS, et al., Plaintiffs,

vs.

THE UNITED STATES, Defendant

FURTHER STIPULATION

The parties stipulated as follows to the documents offered and received in evidence without objection as Trial Exhibit 17, filed herewith:

Page 1 is a document which Mr. Sandhaas, if called as a witness in this cause, would testify is a true copy of a letter he mailed to the named addressee on or about January 8, 1942, and that he also delivered a copy thereof to Bert N. Adams.

Page 2 is a document which Mr. Sandhaas, if called as a witness in this cause, would testify is the original of a letter he prepared and delivered to Bert N. Adams on or about January 20, 1942, and as to which, Mr. Adams, if called as a witness in this cause, would say he received from Mr. Sandhaas and took to Washington, D.C. with him

and showed to Capt. Shumaker between January 21, 1942 and January 24, 1942.

Page 3 is a document which Mr. Adams, if called as a witness in this cause, would testify is a true copy of a letter he mailed on or about February 9, 1942.

[fol. 696] Page 4 is a document which Mr. DePalma, if called as a witness in this cause, would testify is a true copy of a letter he mailed on or about October 7, 1950 and that he delivered a copy thereof to Mr. Adams.

The parties agree that if Adolf Fischbach were called as a witness, he would testify that he has no recollection whatsoever of receiving said letter on October 7, 1950, signed by H. A. DePalma.

Pages 5 and 6 are documents which Bert Adams, if called as a witness in this cause would testify are true copies of letters he received on or about the dates shown thereon.

Page 7 is a document which Mr. Sandhaas, if called as a witness in this cause, would testify is a copy of a letter he received on or about the date shown thereon, and delivered to Mr. Adams.

Page 8 is a document which Bert N. Adams, if called as a witness in this cause, would testify was handed to him by V. F. Payne on August 10, 1943 at the place shown on the letterhead.

Page 10 is a document which Bert N. Adams, if called as a witness in this cause, would testify is a copy of a letter he received on or about the date shown thereon, and that the following pages 11, 12, 13, 14 and 15 were enclosures thereto.

John A. Reilly, Attorneys for Plaintiffs, 165 Broadway, New York 6, New York.

Dated: July 5, 1961

William H. Orrick, Jr., H&B, Assistant Attorney General.

Dated: July 5, 1961

Paul F. Arseneau, Attorney, Department of Justice.

Dated: ——, ——.

[fol. 697] IN THE UNITED STATES COURT OF CLAIMS

TRIAL EXHIBIT NO. 17

January 8, 1942.

Captain Shumaker
Research and Development
Navy Department
Washington, D. C.

Dear Sir:

We have been referred to you by a friend of the writer, Mr. Joseph McMurray, of the Congressional Investigating Committee, at Washington, D. C., as the proper person to whom the following facts should be presented.

A client of ours has perfected a new and unique means of developing electric current known as the "Neutro Cell", patent for which has recently been applied for. Statements of the characteristics and possible uses of this cell are enclosed herewith, together with graphs showing the result of tests made by our client and supported by tests made in the laboratory of the National Carbon Co., at Cleveland, Ohio by their chief Chemist.

Its uses for defense purposes are invaluable considering that it will furnish light and power under such conditions as on a sinking ship, distressed airplane, or any institution where the regular power has failed.

The inventor has three of these cells left for further tests but because its manufacture requires the essential metal of magnesium, he has been unable to obtain this raw material for continued manufacture.

He would appreciate the opportunity of demonstrating the efficiency of this battery at an early date as we feel it will supply a vital need for defense purposes, both at sea and on shore.

Your consideration of this matter will be greatly appreciated.

Very truly yours, John J. Sandhaas.

[fol. 698] WAUD & DOHERTY

Accountants and Auditors
25 West 43rd Street

New York, January 20, 1942.

Bureau of Ordnance
Navy Department
Washington, D. C.

Re: A 13-1 (1/1804) (Rela)

Att: Captain S. R. Shumaker

Dear Sir:

This will introduce Mr. Bert Adams, inventor of the "Neutro Cell", and mentioned in our letter to you dated January 20th.

I am sure a personal discussion of his battery will obviate the need of additional correspondence and feel confident you will find the principle involved in his cell not only interesting but valuable for defense purposes.

Appreciating your kindness in this matter, I am

Very truly yours, John J. Sandhaas.

[fol. 699] N.Y. February 9th, 1942.

Director
Signal Corps Laboratories
Fort Monmouth
Red Bank, N.J.

Dear Sir:

Following my conversation with Mr. Ellis and Mr. Daniels of the Low Temperature Power Laboratory, I am sending by mail a box containing two samples of material used in Neutro Cell.

The contents in the box are: Tube No. 1—positive anode after complete activation.

Tube No. 2—positive anode of fused CuCl as it comes from the mould.

The tubes themselves are samples of the material from which the containers of the Neutro Cell can be made if so specified.

Yours very truly,

Bert Adams
215-10 111 Rd.
Queens Village, L.I.
New York City.

[fol. 700] WAR DEPARTMENT

Signal Corps Laboratories
Fort Monmouth

March 9, 1942.

Refer To: FM (SCL) Proj. S-27.1

Mr. Bert Adams
215-10 111th Rd.,
Queens Village, L.I.

Dear Sir:

It is understood that you are in a position to produce a "Neutro" cell which is better adapted for low temperature operation than those previously submitted to this Laboratory for test.

We desire to obtain a number of these in the "D" size (flashlight cell size) for test at —40F. Please quote on a quantity of twenty (20) cells as follows:

The quotation shall be in triplicate and state:

a. The price, net, f.o.b. Fort Monmouth.
b. Cash discount for 10, 20, 30 days.
c. Time of delivery after receipt of formal order.
d. Period of time in which the quotation will hold.
e. Priority required to obtain material.

The quotation should be addressed to the Contracting Officer, Signal Corps Laboratories, Fort Monmouth, Red Bank, N.J. attention of Automotive and power section, Low temperature Power Group.

Anything you can do to expedite this matter will be greatly appreciated.

Very truly, (Signed) Clarence R. Kingston, Captain Signal Corps, Ass. OC, Field Laboratory No. 2

[fol. 701] WAR DEPARTMENT

Signal Corps Laboratories
Fort Monmouth

March 13—1942.

Refer to FM (SCL) Proj. S-27.1
Mr. Bert Adams
215-10 111 Rd.
Queens Village, L.I.

Dear Sir:

This laboratory would like to obtain ten (10) samples of your Adams "Neutro" cells in the "D" size flashlight cell for experimental purposes.

If it is possible to furnish this Laboratory samples of these batteries for test purpose and this can be done at no expense to the government which is necessary under regulations, we would appreciate you forwarding samples prepaid to the Director, Signal Corps Laboratories, Fort Monmouth, N.J. attention of Automotive and Power section. Low Temperature Power Group.

Very truly yours, (Signed) Clarence Kingston, Ass. OC, Field Laboratory No. 2

[fol. 702] WAR DEPARTMENT

Office of the Chief Signal Officer
Washington

SPSGD 412.42
(Batteries)

SPSGD-W3

June 4, 1942.

Waud & Doherty
25 West 43rd Street
New York, N. Y.

Attention: Mr. John J. Sandhaas

Gentlemen:

Reference is made to your letter of May 28, 1942, addressed to the Chief Signal Officer, regarding the status of tests being conducted at the Signal Corps General Development Laboratory on the Neutro Cell, samples of which you have submitted from time to time.

The Chief Signal Officer has directed me to advise you that the tests mentioned in the preceding paragraph are still being conducted and that, since certain of the tests inherently require considerable time for their conclusion, no findings are available at this time. You will be informed of the results of the Laboratory's tests, promptly upon their conclusion, both as to low temperature and normal temperature applications of the Neutro Cell.

Your interest in the progress of this work is appreciated.

Very truly yours, J. D. O'Connell, Lieut. Colonel, Signal Corps.

[fol. 703] WAR DEPARTMENT

Signal Corps Ground Signal Service
Fort Monmouth Signal Laboratory
Fort Monmouth

Aug. 10, 1943.

To Whom It May Concern,

This will certify that Mr. Bert Adams called at the Fort Monmouth Signal Laboratory on this date to discuss his Neutro cell.

Very truly yours, V. F. Payne, Technical Adviser.

[fol. 704] DEPARTMENT OF COMMERCE

The National Inventors Council
Washington 25

September 2, 1943.

Mr. Burt N. Adams
215-10 111th Road
Queens Village
New York, New York

Dear Mr. Adams:

The War Production Board has approved the use of ten pounds of magnesium sheets. See attached copy of their letter on this matter. We are also returning herewith the priority forms you submitted, since it appears that you can fill your order in New York.

It is hoped that you will now have no difficulty in obtaining the necessary material. This office would be pleased to be kept advised of the results of tests of your battery and any interest therein which may arise.

Yours very truly, J. C. Green, Assistant Chief Engineer.

Enclosures

[fol. 705] IN THE UNITED STATES COURT OF CLAIMS

COMMISSIONER'S EXHIBIT No. 1

MIL-B-17482B(SHIPS) 10 December 1958

SUPERSEDING MIL-B-17482A(SHIPS) 6 November 1956

MILITARY SPECIFICATION

Batteries, Water Activated; and Batteries, Wet, Primary

1. SCOPE

1.1 Scope.—This specification covers primary wet reserve type batteries employed for beacons and countermeasures and sea water activated metallic halide batteries which must remain submerged during discharge.

1.2 Classification.—

1.2.1 Classes.—Batteries shall be of the following classes, as specified (see 6.1 and 6.2):

Class N3.8C300
Class N7.5A435
Class N14A180
Class N22A260

1.2.1.1 Class designation.—The following key shall be used in forming the class designations:

N	3	X	13
Navy	Voltage	Depolarizer	Ampere minute

X (depolarizer) is designated as follows:

A = Silver chloride.
B = Silver oxide.
C = Cuprous chloride.
P = Lead peroxide.

In combination "A" and "B" units, the voltage will be that of the "A" section followed by that of the "B" section. The ampere minutes will be the sum of the ampere minutes of the "A" section and the "B" section. Example: N3-88P47

Where: 3=A, 88=B, and 47=45 ("A") + 2 ("B").

* * * * * * *

[fol. 706] IN THE UNITED STATES COURT OF CLAIMS

COMMISSIONER'S EXHIBIT No. 2(a)

PROCEEDINGS

Tenth Annual Battery Research and Development Conference

Power Sources Division
Signal Corps Engineering Laboratories
Fort Monmouth, New Jersey

[fol. 707] PROGRAM

Tenth Annual Battery Research and Development Conference

23 May 1956

CONFERENCE CHAIRMAN: Mr. W. L. Doxey

PRIMARY BATTERIES

Session Chairman: Mr. C. H. Clark

Leclanche Batteries
Mr. C. G. Birdsall, General Dry Batteries Company, A Division of P. R. Mallory & Co., Inc. 1
Low Temperature Batteries
Dr. A. B. Garrett, The Ohio State University 4
Magnesium Batteries
Mr. J. M. Hovendon, Signal Corps Engineering Laboratories 8
Alkaline Dry Batteries
Mr. J. L. Dalfonso, P. R. Mallory & Co., Inc. 11
Air Depolarized Batteries
Mr. E. A. Schumacher, National Carbon Co., Inc. .. 14

SPECIAL PURPOSE PRIMARY BATTERIES

Session Chairman: Dr. A. Fischbach

Zinc-Silver Oxide Batteries
Mr. N. T. Wilburn, Signal Corps Engineering Laboratories 20
Water-Activated Batteries
Mr. E. M. Morse, The Eagle-Picher Company 23
Thermal Cells
Dr. E. McKee, Catalyst Research Corporation 26
Chlorine Depolarized Battery
Dr. C. L. Randolph, Aerojet-General Corporation .. 29
Organic Depolarizers
Dr. C. K. Morehouse, RCA Research Laboratories.. 32

[fol. 708] WATER-ACTIVATED BATTERIES

Mr. E. M. Morse, The Eagle-Picher Company

The water activated battery systems are among the relatively new power sources which have become extremely important to the Military during the past decade. Their inherent characteristics are such that their use will expand as the Armed Forces continue to utilize more and more equipment to increase the efficiency of the soldier. Batteries of this type are relatively small and light in weight when their power output is compared with other common batteries and they operate with good efficiency over a wide temperature range. They are manufactured as dry primary units and as such are capable of indefinite maintenance-free storage without deterioration. Ordinary tap water or salt water serves as the electrolyte. The definite trend to water activated batteries for high altitude and sea water applications indicates they are unsurpassed as one-shot power packs for low temperature use and for underwater operation.

The most widely used water activated systems are silver chloride/magnesium and cuprous chloride/magnesium. Ten years ago only the silver chloride system was being considered for water activated battery applications. Development programs under the sponsorship of the Signal Corps brought out the feasibility and the economic advantages of the cuprous chloride system. As a result, radiosonde equipment and pilot balloon lighting units were supplied with batteries utilizing this system.

Early applications of water activated batteries involved manual activation procedures in which the battery container was filled with water, then drained thoroughly. This method permitted the successful operation of batteries with voltages of up to 110 volts. Current leakage was minimized because of incomplete electrolyte paths between cells. The advent of the cuprous chloride system as a practical and economical power source quickly aroused intense interest in the field of underwater battery applications. Some of the first immersion type batteries were single cell units, but improved designs showed that potentials up to 6 volts could be tolerated for runs of a few hours duration. The use of freely im-

mersed batteries reached a practical maximum with the design of a 28 volt - 30 minute rate battery. Because of the many advantages of these types of batteries in underwater service, the development of a high voltage battery was of tremendous importance. As a result, an intensified program was carried out which brought about the design of the evacuating type battery. With this innovation, underwater batteries have been produced with potentials of up to 1000 volts and operating life has been extended to about 70 hours.

* * * * * * *

[fol. 709] The development of widespread use of water activated battery systems, and especially the cuprous chloride/magnesium system has helped immensely in rounding out the sources of battery furnished power. In their present fields of application, they offer low unit costs and unlimited storage life, both of which are important to the Military. There can be no doubt that the addition of water activated batteries to the family of power sources has brought about developments which would otherwise have been technically or economically impractical. It appears that present developments will tend to increase the ever-broadening field for the use of water activated batteries.

* * * * * * *

[fol. 710] IN THE UNITED STATES COURT OF CLAIMS

COMMISSIONER'S EXHIBIT No. 2(b)

PROCEEDINGS

Eleventh Annual Battery Research and Development Conference

22-23 May, 1957

Power Sources Division

United States Army Signal Engineering Laboratories
Fort Monmouth, New Jersey

* * * * * * *

[fol. 711] WATER ACTIVATED BATTERIES

E. M. Morse

Eagle-Picher Company

Water activated batteries have become an accepted and important type of portable power supply. As such they play a definite role in both military and civilian applications for reserve power requirements of expendable and emergency equipments. The two water activated systems most widely used are silver chloride magnesium and cuprous chloride magnesium. The silver chloride system has been recognized as a practical battery system for a number of years. The cuprous chloride magnesium battery, however, was developed during the period from 1946 to 1950 by and under the direction of the Signal Corps Engineering Laboratories. This system was developed and has been applied rather extensively solely because of its economic advantage. The major part of the development work which has been carried out since the start of cuprous chloride battery manufacture in 1950 has been directed toward improving the system so that it is capable of replacing the more expensive silver chloride battery. For applications which do not highly restrict space and weight, the cuprous chloride batteries are performing competitively. The principal difference in the space requirements of the two systems is the volume of the pasted cuprous chloride as compared to the rolled silver [fol. 712] chloride material. A large part of the past year's efforts have been devoted to production of high density cuprous chloride plates which will be similar in thickness to silver chloride plates.

Another phase of cuprous chloride battery design which has been underway for some time concerns low temperature operation. The advantage of the exothermic reactions of this system in such applications as radiosonde batteries has been widely demonstrated. However, the adaptation of this battery system for other low temperature requirements has been found to be dependent upon such conditions as the discharge rate, ambient temperature and activated stand. All of the work on this phase has been conducted with pasted type cuprous chloride plates.

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[fol. 713] Water activated batteries are quite well known for their performance at low ambient temperatures. Actually they are capable of low temperature operation not because of high activity plates or low freezing electrolyte, but because the reactions which occur during discharge supply heat. If the temperature in the battery rises too high, the electrolyte evaporates; if it drops too low the electrolyte freezes. In either case the battery ceases to function when the electrolyte is unavailable. In the design of this type battery, it is not difficult to construct units capable of sub-[fol. 714] zero temperature operation at relatively high rates or those capable of normal temperature operation at low rates. But the fact that they generate heat proportional to their discharge rate complicates the design of the high rate, high temperature batteries or low rate, low temperature batteries.

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[fol. 715] IN THE UNITED STATES COURT OF CLAIMS

COMMISSIONER'S EXHIBIT No. 2(c)

PROCEEDINGS

Twelfth Annual Battery Research and Development Conference

21-22 May, 1958

Power Sources Division

U.S. Army Signal Research & Development Laboratory
Fort Monmouth, New Jersey

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[fol. 716] WATER ACTIVATED BATTERIES

Mr. Edward Broglio

The Eagle-Picher Company

INTRODUCTION

The common water activated batteries which we have discussed from year to year continue to find a constant expansion in their field of application. The new devices designed to aid the scientists who work in the field of meteorology often times use water activated batteries to

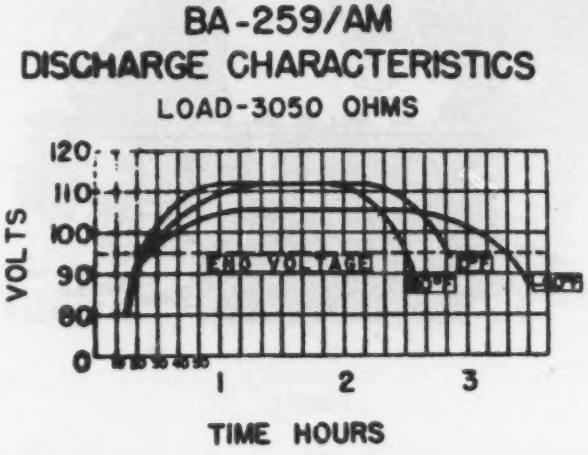
Figure 1

fill their power requirements. The BA 259 unit, of which nearly a million have been built, is the standard example of the successful application of a cuprous chloride battery. (Figure 1) This battery has been supplying much of the power to gather weather information from radiosonde balloons. A host of similar batteries have been designed for like applications, that is, batteries which consist of an "A" and a "B" supply to operate light-weight transmitters. The most significant point about these batteries is that they operate under environmental conditions which would nor-

mally freeze the electrolyte and cause them to be inoperative.

Discussion

In the past, much time has been spent discussing the exothermic reactions which cause these batteries to generate heat and maintain their temperature substantially above the ambient. Everyone knows and understands that these side reactions allow these batteries to operate at —65°F: however, the same heat which causes them to operate in cold temperatures, tends to cause the reactions to fail when normal or high temperatures are involved. Simply because the BA-259 is successful does not mean that any battery requirement can be filled by a water activated unit. The fact that the battery electrolyte is capable of ionic conduction in a narrow temperature band precludes the indis-



[fol. 717] criminate application of these units. The BA-259 is successful because of a particular combination of conditions. (Figure 2) The load on the BA-259 is high enough to cause the unit to generate sufficient heat to operate at —65°. The load is low enough in comparison to the physical size of the battery that it will not boil the electrolyte dry too quickly when the unit is operated at normal temperatures. If the load current were changed to reduce the power required from the battery, then operation at

—65°F would be shortened while operation at normal temperatures would be prolonged as the current is reduced.

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[fol. 718] CONCLUSIONS

We hope this presentation has clarified the limitations of the water activated battery system in so far as low temperature operation is concerned. These cuprous chloride-magnesium batteries are inexpensive in production, relatively simple to activate, deliver good output compared to their weight and volume, and have proven their excellent storage life capability. They will continue to fill an important part of the military battery requirements.

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[fol. 719] IN THE UNITED STATES COURT OF CLAIMS

PLAINTIFFS' EXHIBIT No. 16

SPECIAL PURPOSE BATTERIES

Adolph Fischbach

Standard-type primary and secondary batteries are unsatisfactory for certain types of Army and Air Corps equipment and, consequently, special purpose batteries suitable for these particular applications had to be developed. This article* describes three systems which have been found to be the most effective at the present time.

As the Signal Corps was given the general responsibility for supplying primary battery power for specialized types of equipment for the Army and Air Corps, it was necessary to set up a program which would arrive at an interim solution to some of these applications, as well as a long-term research and development program which would result in a standard line of special purpose batteries suitable for such applications. Because of the demand for high discharge rates, high capacity per unit of volume and weight, and other stringent requirements, it was soon recognized that the standard-type primary and secondary types of batteries would be unsatisfactory for these special applications.

One of the first steps in the development of a line of batteries for these applications was to set up general specifications based on a review of all application requirements which had been received.

Obviously, an extensive program of research and development had to be carried on if batteries were to be developed which would give optimum performance in line with these stringent requirements. The Battery Branch of the Signal

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* Third in a series of three articles on batteries. The first was "Primary Batteries," C. H. Clark (*EE, June '50, pp 515-18*), and the second was "Military Storage Batteries," Hyman Mandel (*EE, Jul '50, pp 619-21*).

Adolph Fischbach is with the Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

Corps Engineering Laboratories has been active for some time in this type of investigation, both through internal laboratory work and by contractual activity. Information obtained on experimental contracts, such as those with the universities, industry, and research laboratories, is also being utilized in the solutions of these problems.

Of necessity, numerous electrochemical systems and designs were considered and preliminarily investigated in order to select systems which were considered the most promising at this time. Considerable progress has been made to date on this activity. Studies have been and are being made on the characteristics of battery electrode materials as well as on the development of designs to give the desired performance characteristics. In addition to finding an interim solution to some of these problems, these laboratories have for some time been carrying on a long-range program to cover this special application field. A complete report on all of the investigations cannot be given at this time.

However, some of the highlights of the systems and designs which to date have been found to be the most effective interim solution to specific application problems will be presented. The systems which will be discussed are: the magnesium, water, cuprous-chloride system; the zinc, potassium-hydroxide, silver-peroxide system; and the cadmium, acid, lead-peroxide system.

Of the three afore-mentioned systems, the magnesium, water, cuprous-chloride system seems to offer the best solution for some of the specialized applications, particularly those where the battery has to be stored for long periods of time; where the battery has to be easily activated at the time it is required for operation; where the power can, or will, be used within a comparatively short time after activation; and where the capacity required per unit of weight and volume is exceptionally high. The battery must, of necessity, be activated at more or less normal temperatures (above the freezing point of water). Since heat is generated during the course of the discharge, this system can be utilized in powering equipments going into cold temperatures, if the proper heat balances are maintained.

Examination of its characteristics indicates that the magnesium, water, cuprous-chloride system should be capable of meeting the cold temperature conditions indicated above. For this reason, much emphasis has been placed on the utilization of this system for such applications.

Work on the development of the magnesium, water, cuprous-chloride system was first started in the early part

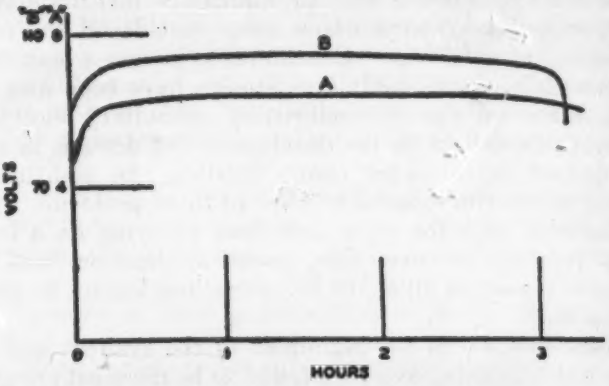

Figure 1. Discharge of dunk-type magnesium cuprous-chloride meteorological battery. The A unit was discharged through 28.4 ohms, and the B unit was discharged through 3,833 ohms. The battery was discharged for five minutes at 80 degrees Fahrenheit and at −58 degrees Fahrenheit for the remainder of the time

[fol. 720] of 1946. Early tests had indicated its possibilities as a relatively inexpensive high-capacity battery. Although the system was first thought to be impractical for battery applications due to its initial self-discharge and evolution of heat, the Signal Corps, by continued effort in its Engineering Laboratories, developed a practical operating cell. Then through co-ordinated effort with the battery industry, this cell was developed into a practical battery, utilizing the so-called "dunk" construction, a design where the cells are individually wrapped and joined externally by a series of welds. The tops and bottoms of the cells are left open. This battery at the present time meets some of the special application requirements demanded by the various services.

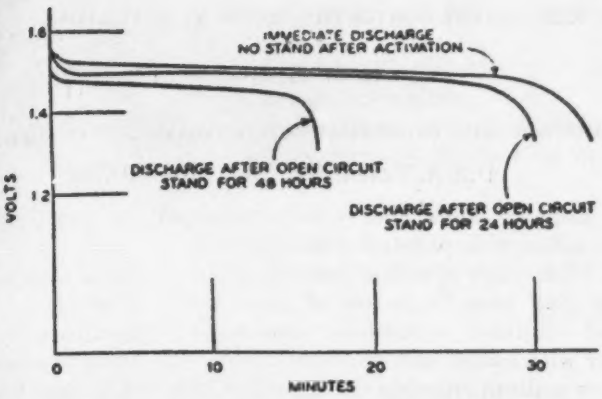

Figure 2. Discharge characteristics of zinc, potassium-hydroxide, silver-peroxide cells after various stand periods after activation. Discharges were at 20 amperes and 80 degrees Fahrenheit

Figure 1 shows a curve of specification discharges carried out on one of these batteries. The battery was activated by dunking in an electrolyte of water containing 1-per cent cadmium chloride and ¼-per cent ammonium chloride, then shaken to remove excess electrolyte. It was discharged for five minutes at 80 degrees Fahrenheit and then placed in the —58-degree-Fahrenheit cabinet for the remainder of the run. As can be seen from this figure, the discharge curve of both the *A* and *B* sections is exceptionally flat and uniform.

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[fol. 721] IN THE UNITED STATES COURT OF CLAIMS

PLAINTIFFS' EXHIBIT No. 17

INSTRUCTION SHEET FOR TESTING ADAMS NEUTRO CELL

U.S.A. Patent No. 2,322,210—1943

1. Remove filler hole wooden stopper by twisting off. This stopper is painted with Red dot.

2. Pour into opening uncovered by wooden stopper to about half inch from top of glass cell jar, either—faucet water—distilled water—or salt water regardless if just water with added salt or ocean water. The chemical impurities or sodium chloride do not effect this cell in any way or form. There is no chlorine gas liberated by using salt water.

3. Place load across terminals. Center terminal is positive and other terminal is negative.

4. Open circuit voltage will become effective immediately upon pouring water into cell jar. Current will develop with an upward curve from 0 to maximum for the particular cell under test in between 10 to 25 minutes from the time the load was applied. Warm water of about 150 degrees F. will cause current to flow in about 3 minutes. A direct short across terminals will hasten the maximum current flow. This short should be broken within 10 minutes and cell will then give it's rated current.

5. After cell is activated load can be removed and replaced at will. Cell will consume it'self about one fourth of it's energy during open circuit therefore this cell can be used to advantage only on short duration where a large current is desired, i.e. Miners lamp, emergency source of power etc. Filament current for large portable Army and Navy Radio equipment.

6. The drain and voltage given on individual cells is only approximate due to error in spacing the cell elements. This error cannot be avoided with sample cells manufactured in my laboratory due to poor tooling and makeshift cell containers.

7. All containers used in these sample cells are far too large for the cell size used and the spacing between plates is about 3 times too great for the cell. This is due to the difficulty of obtaining square jars or tin cans as containers.

8. The internal temperature of a fully activated cell is app. 94 degrees Fahrenheit.

9. This cell will work and has been tested at a continuous temperature of 175 degrees Fahrenheit.

10. These cells, by an addition of sodium chloride will operate at the low temperature of 20 degrees below zero Fahrenheit.

11. Please remember that these samples are laboratory test units and not standardized commercial cells and were manufactured under difficult conditions on the kitchen stove.

July 13, 1943. Bert Adams.

[fol. 722] IN THE UNITED STATES COURT OF CLAIMS

PLAINTIFFS' EXHIBIT No. 18

BURGESS A.M. POWER UNITS OFFER A NEW TYPE OF HIGHLY PORTABLE POWER SUPPLY

Constant Voltage—Constancy of voltage is an important factor in electronic equipment. In this respect A.M. Power Units have a definite advantage because they deliver practically constant voltage throughout their service. In Figure 1 typical discharge curves at several current densities show the steady voltage obtained during most of the life of the power unit. Moreover, the voltage is not greatly affected by the current drain. Increasing the current 16-fold only lowers the *peak voltage* from 1.60 to 1.52 per cell.

The graphs show that a short initial build-up time is required to reach peak voltage. In many applications, this voltage build-up time can be disregarded, but if operating voltage is required promptly, methods are available for shortening the build-up time.

High Current and Power Output—A.M. Power Units deliver power equal to that of batteries many times larger. Single cell units scarcely larger than an ordinary flashlight cell can deliver currents as high as 100 amperes, at approximately 1.4 volts. Standard units have been built to deliver up to 30 watts per cubic inch or 360 watts per pound. For obtaining high power from a small source, A.M. Power Units are unexcelled.

Constant Output—Whatever the load, the energy output of A.M. Power Units is practically constant. Figure 1 shows that there is only a moderate decline in capacity as the current density goes down. At much higher current densities, there is also a slight decline in output, but at any current density up to 25 amperes per cubic inch the capacity will be within about ±20% of the average output.

Light Weight—In most cases, replacing generators or ordinary batteries with A.M. Power Units will mean a considerable reduction in weight. In one high-intensity lighting unit, the weight was reduced more than 50% by the use of A.M. Power Units, and at the same time a brighter and more constant light was obtained. In another case,

where storage batteries weighing over 20 pounds had been recommended, an A.M. Power Unit weighing only 7½ pounds was used successfully.

Long Shelf Life—A.M. Power Units are supplied in dry form, and are normally shipped in sealed containers. Since they are free from moisture, no deterioration occurs in storage and the shelf-life is indefinitely long. The power units can be built into the equipment that they will operate, and will be ready to operate whenever they are needed.

Types Available—All A.M. Power Units are made up of unit cells which have a nominal rating of 1.5 volts per cell (closed circuit voltages are shown in Figure 1). Higher voltages are obtained by connecting cells in series. Higher capacities are usually obtained by using larger cells, although parallel connections can be used. Single cell A.M. Power Units are cylindrical in form, and consist of parts wound together spirally. Standard units have ratings from 7½ to over 1000 ampere minutes.

Low-voltage multiple cell units may be composed of separate cells, arranged inside a case, or several cells may be wound concentrically. The concentric construction gives the maximum space economy.

"B" batteries consist of flat cells, arranged in rectangular units and ordinarily furnished in light-weight cases. Standard units have nominal capacity ratings from 1 to 4½ ampere minutes.

Method of Use—A.M. Power Units are shipped in dry form, and are readily activated when they are required for use. The units are simply immersed in ordinary water from a few seconds to one or two minutes to saturate the cells; then they are removed and are ready to operate. No particular quality of water is needed; distilled water, common tap water, lake water, or sea water will serve equally well. If more convenient, low voltage units can be left submerged in the activating liquid, usually with negligible loss, but standard high-voltage power units must be removed from the activating liquid. (Special types of high-voltage power units can be furnished where the units must operate submerged.)

In most cases, it is most convenient to activate the power units before the load is connected; however, the load can be connected before activation if required by operating condi-

tions. When A.M. Power Units are built into special equipment, automatic means for activating them may be required.

Wide Temperature Range—While A.M. Power Units must be activated at temperatures above the freezing point of water, they can be successfully discharged at ambient temperatures as low as —60°F. The heat produced within the battery keeps it from freezing. Temperatures as high as 150°F. are not detrimental.

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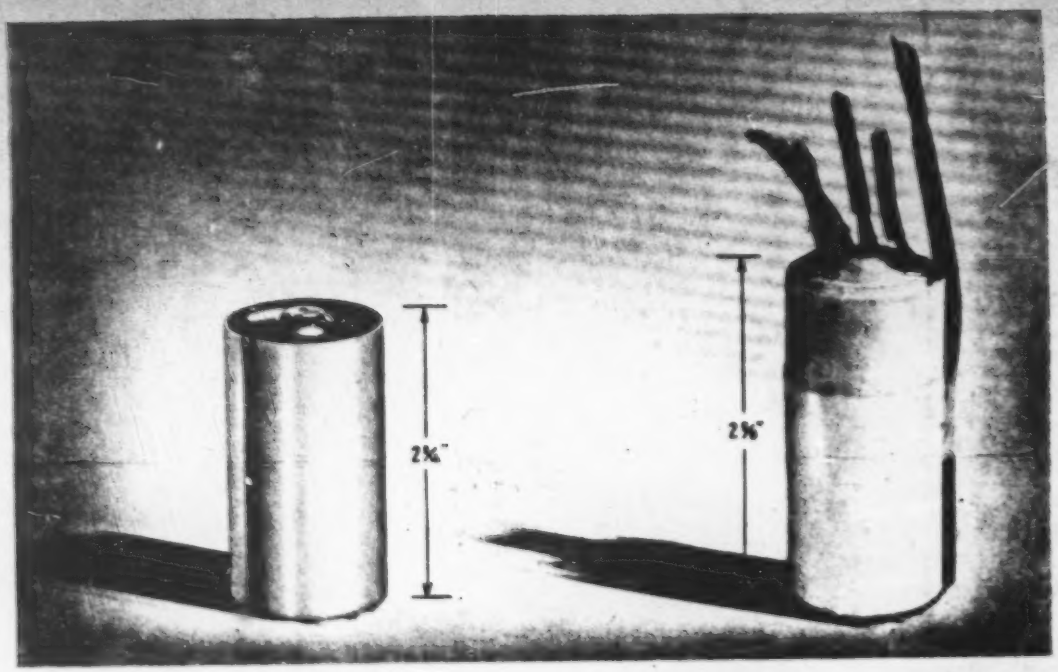
A. M. POWER UNITS HAVE MANY APPLICATIONS



DRY CELL (SIZE D) 5 AMPERE FLASH CURRENT AT ALMOST ZERO VOLTAGE. WEIGHT 100 GRAMS.

A. M. POWER UNIT 100 AMPERE CURRENT AT 1.35 VOLTS. WEIGHT 148 GRAMS.

A. M. POWER UNITS were developed during the war for important military and naval applications, some of which are still restricted. They are now available for civilian use. Some of the many applications for which they are used are included in the following list:

- Airborne electronic equipment
- Meteorological equipment
- Signal lights
- Emergency flares
- Lights for pilot balloon observations
- Marker lights for floating buoys
- Light units for movie work
- Motors
- Radiosonde units for weather observation
- Emergency radio equipment
- Air-sea rescue equipment
- Ignition systems
- Emergency lights for hospitals
- Direction-finding equipment

To obtain more complete information on the application of A. M. POWER UNITS to a specific problem, consult our design engineers. They will assist you in selecting the right A. M. POWER UNIT for your job.

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[fol. 724] IN THE UNITED STATES COURT OF CLAIMS

PLAINTIFFS' EXHIBIT No. 19

RAY-O-VAC
Trade Mark
Engineering Bulletin

CHARACTERISTICS OF THE MAGNESIUM CUPROUS CHLORIDE BATTERY

Description—The magnesium-cuprous chloride battery is a new type of water activated battery designed to operate under certain types of extreme conditions in which normal dry batteries will not function efficiently. The battery is shipped dry in a moisture proof container and water or a solution must be added to activate it. Once moisture is added, the battery dissipates itself until exhausted, whether under load or not. Open circuit periods extend the overall use period, limited by the length of time moisture is present.

Temperature Range—Satisfactory operation at temperatures ranging from +140°F. to —60°F. or at altitudes of 100,000 ft. is an important characteristic. Heat generated from reactions within the battery prevents freezing during low temperature operation.

Light Weight—The light weight of magnesium-cuprous chloride units compared to conventional dry batteries of comparable capacity make them extremely desirable for applications where weight is an important factor. A rough overall comparison is ⅓ of dry battery weight before activation and ½ when activated.

Activation and Operation—Ordinary tap water or sea water may be used for activation. Water is added, allowed to remain in the battery for a short period, and the excess then removed. The battery will, in most applications, rise to operating voltage in less than one minute or, if required, this voltage rise can be extended over a much longer period. Low voltage batteries will operate satisfactorily completely submerged in water.

Constant Voltage—A fairly constant voltage throughout its useful life is an important characteristic of this battery. The voltage drop is dependent, to a large extent, on the cur-

rent drain and it is possible to obtain a fairly flat voltage curve under proper conditions. Typical discharge curves are given later in this bulletin.

Long Shelf Life—As long as the battey is kept free from moisture, it may be stored almost indefinitely without excessive deterioration. All batteries are packed for shipment in moisture proof containers, and as long as they are not opened their shelf life is excellent.

Power Output—Single cells can be designed to operate successfully under current drains of less than one milliampere and in excess of one ampere. These single cells can be assembled into battery units that will meet almost any voltage and current requirement.
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[fol. 725] IN THE UNITED STATES COURT OF CLAIMS

PLAINTIFFS' EXHIBIT NO. 37

JOURNAL OF THE ELECTROCHEMICAL SOCIETY

August 1952.

SILVER CHLORIDE-MAGNESIUM RESERVE BATTERY

Ivan C. Blake[1]

Silver chloride-magnesium water-activated batteries first became available on a commercial basis in 1943. In the period of 1943-45, several battery types using silver chloride-magnesium water-activated cells were produced for the military. In the period of 1945-52, applications for these batteries became more numerous and batteries are now produced on a commercial basis for a diversified list of military and civilian uses.

The silver chloride-magnesium cell consists of an anode of unalloyed, high purity magnesium, a cathode system of

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[1] Burgess Battery Company, Freeport, Illinois.

silver and silver chloride, and an absorbent separator of cellulosic material. The cells are maintained in the inactive state by assembling the dry elements into cells or batteries in the absence of electrolyte and immediately packing the cells or batteries in hermetically sealed containers. At the time the cells or batteries are used, they are immersed in water to render them active. When the cell is discharged, the following reactions take place:

$$Mg \rightarrow Mg^{++} + 2e$$
$$2AgCl + 2e \rightarrow 2Cl^{-} + 2Ag$$
$$Mg^{++} + 2Cl^{-} \leftrightarrows MgCl_2{\cdot}6H_2O.$$

The reactions proceed with great rapidity and the cell develops its full voltage and current delivering power very rapidly. Inasmuch as the silver chloride is reduced to silver metal, the electronic conductivity of the depolarizer mass is increased as the discharge reactions proceed and the operating voltage of the cell is maintained at a high and constant value. When the silver chloride is completely reduced to silver metal, the voltage falls rapidly.

The operating voltage of cells and batteries ranges from 1.32 v per cell at a discharge current density of 2.00 amp/cm^3 (32.78 amp/in.^{3}) or 0.072 amp/cm^2 to 1.60 volts per cell at a discharge current density of 0.006 amp/cm^3 (0.10 amp/in.^{3}) or 0.0002 amp/cm^2.

Silver chloride-magnesium batteries, after activation in water at temperatures above 0°C, can be discharged at ambient temperatures ranging from +94°C to −54°C, with outputs at either extreme of the temperature range being substantially the same as the output at +21°C.

Several variations of cell and battery designs are manufactured. A cell for discharge at extremely high current densities consists of an anode of thin magnesium sheet and a cathode of silver foil, upon the surfaces of which a layer of silver chloride has been electroformed, separated by a layer of thin absorbent paper. The cell components are rolled up to form a cylindrical cell having a large active surface area per unit of volume. Such cells are usually designed for discharges to be completed in 30 minutes or less.

Batteries for applications requiring lower current densities, longer life (0.5 24 hours), and a relatively constant discharge voltage are made from cells using flat depolarizer

sheets of rolled silver chloride, magnesium sheet anodes, and relatively thick absorbent pads as separators.

Silver chloride-magnesium water-activated batteries are available in sizes ranging from 1 to 1050 ampere minutes rated capacity and in voltages ranging from 1.5-150.

Performance of the silver chloride-magnesium water-activated battery is shown in Fig. 1 and 2.

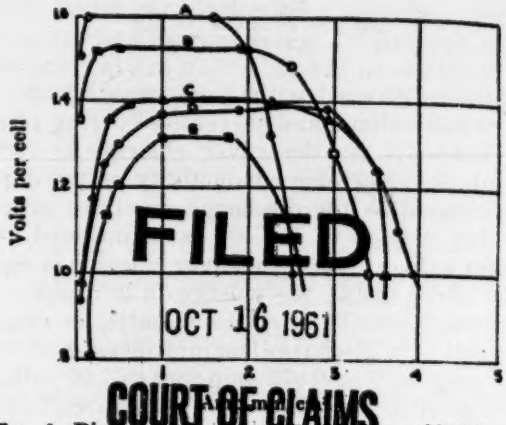

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FIG. 1. Discharge characteristics of silver chloride-magnesium cell.

Curve	Discharge current		
	Amp/cm²	Amp/in.²	Amp/cm² of electrode area
A	0.006	0.098	0.0002
B	0.100	1.639	0.0034
C	0.500	8.195	0.0180
D	1.000	16.300	0.0360
E	2.000	32.780	0.0720

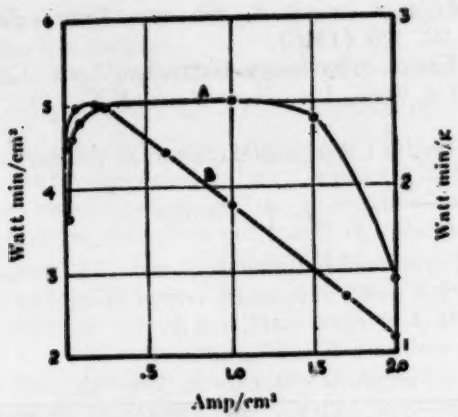

FIG. 2. Output per unit of volume (A) and weight (B) for the silver chloride-magnesium cell.

These batteries are used in airborne electronic equipment, signal lights, emergency flares, lights for pilot balloons, marker lights for buoys, light units for movie work, motors, Radiosonde units for weather observation work, emergency radio equipment, air-sea rescue equipment, ignition systems, emergency lights for hospitals, and direction finding equipment.

Silver chloride-magnesium water-activated batteries are characterized by high current and power output, constant [fol. 726] potential, light weight, long shelf life in the inactivated condition, and are capable of being discharged at temperatures ranging from +94°C to −54°C. They have the disadvantages of being relatively high in cost (because of the silver content) and of inconvenience of activation procedures in certain applications.

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2. H. E. LAWSON (To U. S. A.), U. S. Pat. 2,445,306, July 13, 1948.
3. J. B. MULLEN (To Burgess Battery Co.), U. S. Pat. 2,521,082, Sept. 5, 1950.
4. L. H. HARRISS (To Burgess Battery Co.), U. S. Pat. 2,543,106, Feb. 27, 1951.

5. J. B. Mullen and P. L. Howard, *Trans. Electrochem. Soc.*, 90, 529 (1946).
6. G. W. Vinal, "Primary Batteries," pp. 274-279, John Wiley & Sons, Inc., New York, N.Y. (1950).

The Cuprous Chloride-Magnesium Reserve Battery

L. E. Pucher[1]

Cuprous chloride-magnesium, water-activated reserve-type batteries were first made commercially in 1949, these having been developed particularly for the military. Several types are now being produced.

The use of cuprous chloride as the oxidizing agent in a primary pile-type battery was suggested as early as 1891 in a British patent (1), in combination with a zinc anode and a 40 per cent zinc chloride electrolyte. Adams (2) in 1943 patented a reserve-type cell having a magnesium cylindrical can anode with a cathode core of fused cuprous chloride cast around a copper core.

The cells and batteries now being made are of the pile type. A sheet of magnesium of at least commercial purity is separated from the cuprous chloride cathode by a porous separator made of various natural or synthetic textile fibers. This separator also serves to retain the aqueous activating liquid. The cathode is preferably of the pasted type which activates much more rapidly than the fused type. It is made by applying a paste of powdered cuprous chloride and a liquid binder onto a suitable base, such as a grid of copper or bronze screen, though copper foil may be used. A suitable binder is polystyrene dissolved in an organic solvent such as toluol. Aqueous salt solutions also may be used as binders.

The battery of assembled cells is taped together under pressure. Uniform pressure and separator spacing throughout the assembled battery is essential for efficient operation. Because cuprous chloride is hygroscopic, assembled cells and batteries must be stored in dry sealed containers until activated to prevent the formation of cupric chloride.

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[1] The Willard Storage Battery Company, Cleveland, Ohio.

Absorbed moisture lowers the discharge voltage markedly and decreases the output.

During discharge the following reaction ocurs:

$$Cu_2Cl_2 + Mg + CH_3O \rightarrow 2Cu + MgCl_2 \cdot CH_3O.$$

The performance of a representative cuprous chloride-magnesium, water-activated battery is shown in Fig. 1. A short voltage build-up time of 1 to 10 minutes is required after activation but this does not result in appreciable self-discharge. However, the cell should be used immediately after this voltage build-up. The open-circuit voltage varies with test conditions, rising to a maximum of 1.70 to 1.80 at 22°C (72°F). Because the discharge reaction proceeds rapidly the cell voltage is maintained at a high value until the cell is exhausted as shown in Fig. 1. The formation of $MgCl_2 \cdot 6H_2O$ tends to block the cell because its combined

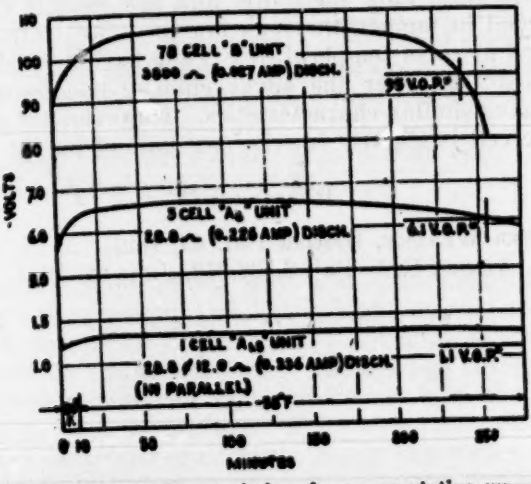

Fig. 1. Output characteristics of a representative cuprous chloride-magnesium battery pack comprising a 78 cell "B" unit discharged on 3800 ohm, a 5 cell "A" unit discharged on 28.8 ohm and an additional load on one "A" cell (bottom curve).

Curve	Amp	Min service	Amp cm²	Volts	Amp min. cm²	Watt min cm²
Top.....	0.027	240	0.010	1.34	2.30	3.19
Middle.....	0.226	255	0.016	1.31	3.23	5.13

water is obtained at the expense of the water added to activate the cell.

This couple is best suited to discharges at low current densities, for example, 0.0065 to 0.049 amp/cm^2 (0.027 to 0.318 amp/in.^{2}) of anode surface in cells having a volume of 1.64 to 3.88 cm^2 (0.107 to 0.236 in.^{2}). The discharge reaction is sufficiently exothermic to cause overheating on high current drains. This characteristic can be utilized to advantage in cells which must be operated in extremely low temperatures, for example, at −50°C (−58°F) after activating at room temperatures. Under these conditions the discharge characteristics are similar to those obtained at room temperatures (Fig. 1). The discharge efficiency is relatively low, probably of the order of 30 per cent.

[fol. 727] Cuprous chloride-magnesium batteries are characterized by good current and power-output, almost constant potential, long shelf life, and are capable of being discharged in temperatures as low as −50°C after being activated at room temperature. They have a considerable cost advantage over the silver chloride-magnesium cells which have similar characteristics. However, the cuprous chloride cell is slightly heavier per unit of output.

References

1. Walter Wensky, British Pat. 49, 1891.
2. B. N. Adams, U. S. Pat. 2,322,210, June 22, 1943.

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[fol. 728] IN THE UNITED STATES COURT OF CLAIMS

PLAINTIFFS EXHIBIT No. 39

A paper presented at the Ninetieth General Meeting held at Toronto, Canada, October 19, 1946, George W. Vinal presiding.

CHARACTERISTICS OF THE SILVER CHLORIDE-MAGNESIUM WATER ACTIVATED BATTERY †

By J. B. Mullen and P. L. Howard [1]

ABSTRACT

The development of and experience gained from large-scale production of the silver chloride-magnesium water activated primary battery is presented. A summary is given of preparation of materials, methods of construction, electrolytes, and discharge characteristics. Size, weight, and analysis of results obtained on 21 different production units are shown. The batteries offer outstanding merits where uniform high terminal voltage over a wide range of currents and temperatures is desired.

INTRODUCTION

At the beginning of the war, a serious need arose for extremely light weight, small size, high powered batteries. This was necessitated by the many advances in electronic equipment for the armed forces. The storage batteries and dry cells were either too large or did not have the desired capacity to meet the demands of the new light weight and small size electronic equipment. Early experience showed that an indefinite storage life was necessary for batteries to be used in all parts of the world. To overcome these difficulties, the armed forces set out to find possible new types of batteries which had not been exploited. One of these types was the silver chloride-magnesium water acti-

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vated battery which was developed at the C. F. Burgess Laboratories, Inc.

The usefulness of silver chloride as a depolarizer has not previously been exploited further than use as reference electrodes and one type of voltaic cell. This cell was of the pasted silver chloride-zinc type made similar to the Leclanché dry cell. Probably the main reason for lack of exploitation was due to low voltage of 1.0 volt per cell and low ampere discharge rates. No work had been done on use of other negatives such as magnesium to increase the voltage of such a system and render it more widely useful. [fol. 729] This study was undertaken to develop a cell which would have these properties:

(1) As high a voltage as possible, preferably at least 1.5 volts per cell.

(2) Long storage characteristics, preferably indefinite by long storage.

(3) Low weight per watt-hour output.

(4) Ability to deliver its energy rapidly, that is, at high currents.

Silver chloride and magnesium were selected as components, after testing numerous other couples, because of the interesting combination of excellent depolarizing action and high voltage.

Design and Construction

To achieve the objectives outlined above, the silver chloride-magnesium battery was developed as a reserve type battery with the electrolyte to be added just prior to use. A compact, simple, and efficient design of spirally wound cells was developed which is used in batteries with capacity over about 5 ampere-minutes. The positive electrode of each cell consists of silver foil, 0.001 in. (25 microns) to 0.003 in. (76 microns) thick, coated with electrolytically formed silver chloride on both sides, with wire leads welded on. The electrochemical equivalent of the deposits range from 0.75 to 5.0 amp.-min./sq. in. (0.12 to 0.78 amp.-min./cm.^{2}) depending on current, life, and output required in the end use. The negative electrode consists of commercially pure magnesium foil (supplied by Dow Chemical Company) of the same width, to which a similar wire lead is welded. The two electrodes are wound

spirally together, with dry absorbent paper interleaved between the two electrodes. This forms a cylindrical cell with wire leads at the ends. The cell thus formed in its dry condition is completely inert and will keep indefinitely. The absorbent paper is an effective barrier between the silver chloride and magnesium electrodes. When saturated with an electrolyte, the absorbent paper becomes a con- [fol. 730] ductive medium and the cell can be discharged through a suitable resistance.

TABLE I

Output of Various Types of Batteries for Pilot Balloon Light Service

Discharge Tests at Room Temperature

Type	Load	Life to End Voltage	Total Output (Amp.-Min.)[1]	Weight[2]	Amp. Min. per Gm. per Cell	Per cent of Life Above 95% of Max. E.	Per cent of Life Above 90% of Max. E.
Dry (2-*AA*).....	10 ohms	16 min.	3.2	31g.	0.21	..	12.5%
P.A. (*BB*-211/*AM*)	10 ohms	76	26.2	50	1.02	39%	66
Lead-Acid (*BB*-219/*U*).....	PR–10 (12 ohms)	44	21.2	150	0.57	79	95
AgCl-Mg (2*CC*15)..	10 ohms	52	15.8	26	1.22	88	94
AgCl-Mg (4*CC*25)..	PR–10 (12 ohms)	63	33.2	70	1.90	89	97

[1] To end voltage given in text.
[2] Complete battery, including electrolyte, socket, and lamp.

To make a battery of two or more cells, it is convenient to wrap the first cell with a layer of an insulator such as plastic film or varnished paper, after which the second cell is wound on like the first and concentric with it. This "concentric capsule" construction is applicable to low voltage batteries for high and low rates of discharge where space and weight are at a premium.

For high voltage applications, in which current and total output are low, the batteries are preferably made up in flat-cell form. Area of these cells ranges from 0.59 to 2.625 sq. in. (3.78 to 16.8 cm.^{2}). In such cells the silver chloride is formed on only one side of the silver sheet. Batteries are made up by stacking plates with absorbent paper between the electrodes of each cell and insulation between adjacent cells.

The batteries are manufactured at a temperature of 27° C (80° F) at a relative humidity of 20%, or an absolute humidity of 0.0045 lb. of water per pound of dry air. Such

air has a dew point of 3.33° C (38° F). The batteries are packaged in sealed cans in this atmosphere with a small quantity of silica gel as desiccant. Under these conditions, storage life is excellent.

At the time of use, the battery is removed from the sealed container and is activated by immersion in common or salt water to saturate the absorbent paper. It may be discharged either after removal from the water, or while immersed continuously, *i.e.*, in the case of low voltage batteries.* This eliminates the necessity of special electrolyte chambers, or storing a special electrolyte since water is universally available.

When tap water is used as electrolyte, the low initial concentration of ions causes a comparatively slow rise in voltage for the first few seconds; but chloride and magnesium ions are rapidly produced by the cell action, which increases the conductivity of the electrolyte. Voltage ordinarily rises to nearly the peak within one to two minutes. If faster voltage rise is required, sea water or a dilute salt solution is used to supply sufficient ions at the start.

Test Results

One of the outstanding characteristics of the silver chloride-magnesium cell is the steady voltage obtained on discharge. Fig. 1 shows the comparative shapes of typical discharge curves of Leclanché, perchloric acid, and silver chloride-magnesium cells. The perchloric acid cells have a positive electrode of nickel wire screen electrolytically coated with lead peroxide surrounded by lead sheet. This cell, which is generally considered to have an approximately flat discharge curve, actually has a slow, almost linear decline in voltage throughout its useful life. The shape of the curve is very similar to that obtained with the lead peroxide-sulfuric acid-lead storage cell. Leclanché cells are characterized by a comparatively rapid drop during the first quarter of their life, followed by a slower but steady decline during the latter part of the life. On intermittent [fol. 731] service, the same type of curve is obtained except that there are stepwise increases in voltage after each rest

* Specially designed cases for high voltage batteries permit operation while continuously submerged.

period. In contrast to these, the discharge voltage of the silver chloride magnesium cell actually rises somewhat at the start, after which it remains nearly constant at about 1.5 volts on load for most of the life of the cell. At the end of discharge, the decline in voltage is quite rapid and continues rapidly until about 0.3 v./cell is reached.

The silver chloride-magnesium cell will deliver an extremely high current at a useful voltage. This is not a

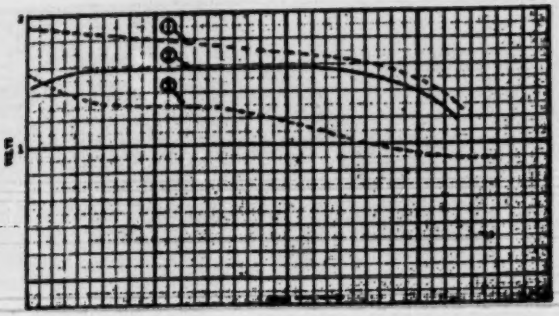

FIG. 1. Typical discharge curves of 3 types of batteries. Curve 1, perchloric acid type; curve 2, silver chloride-magnesium type; curve 3, dry cell.

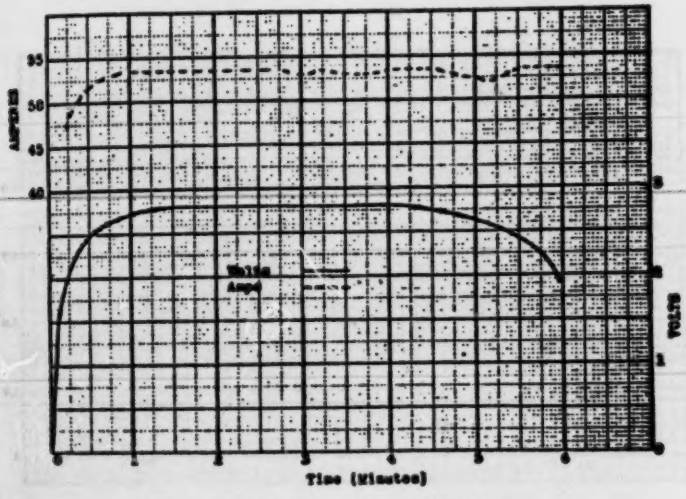

FIG. 2. Discharge curve of type 2CC304 battery.

matter of flash current on short circuit; the high current can be delivered at 1.3 to 1.5 v./cell.

Fig. 2 shows the discharge curve of a 2-cell battery, type 2*CC*304, at a current of 53.5 amp.; voltage reaches a maxi- [fol. 732] mum of 1.42 v./cell. Dimensions are given in Table III. As an additional example of the high current generating characteristic of the silver chloride-magnesium cell, a cell 1.375 in. (3.5 cm.) in diameter x 2⅝ in. (6.7 cm.)

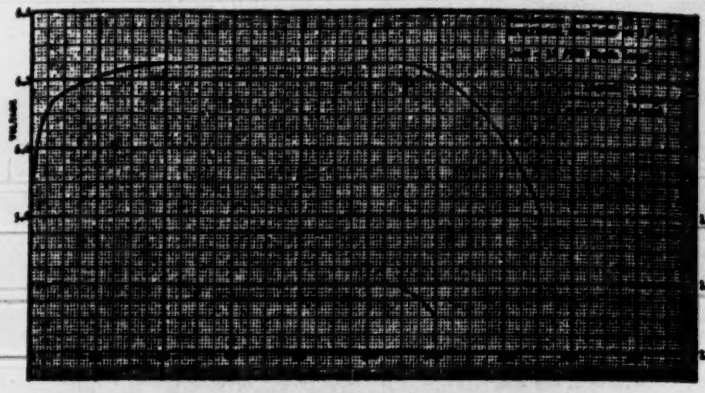

FIG. 3. Discharge curve of type 4CC200 battery.

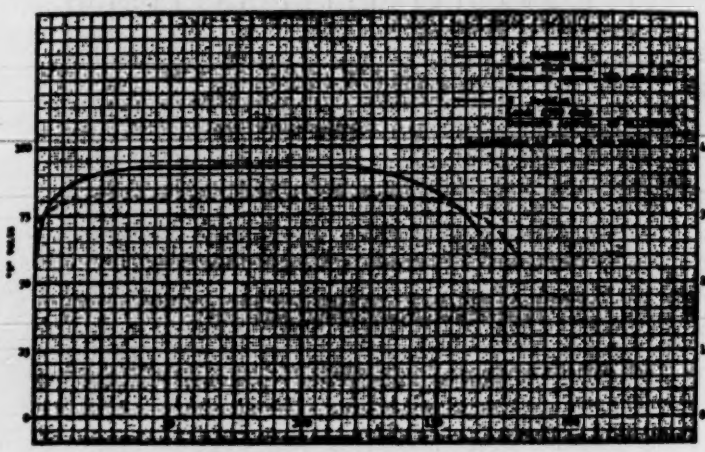

FIG. 4. Discharge curve of "A" and "B" battery type 2MC40-60B1.

long delivered a current of 100 amp. at a peak of 1.40 v. for 1.5 minutes. Such performance is not a laboratory curiosity but in both cases was obtained on production models of batteries.

While the silver chloride-magnesium cell is particularly adapted to production of high currents, it is not limited to this class of service. Batteries have been constructed and operated successfully at currents as low as 7 milliamp. and for continuous service as long as 48 hours. Fig. 3

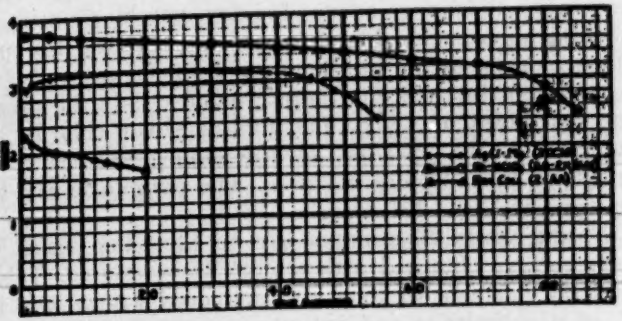

FIG. 5. Comparison of silver chloride-magnesium, perchloric acid, and dry cell batteries. Silver chloride-magnesium battery, 2 cells type 2CC15. Positive plate area 24.5 sq. in.; activated in tap water for 60 seconds. Perchloric acid battery type *BB-211/AM*. Dry cell, 2-*AA* cells in series. Load 10 ohms continuous.

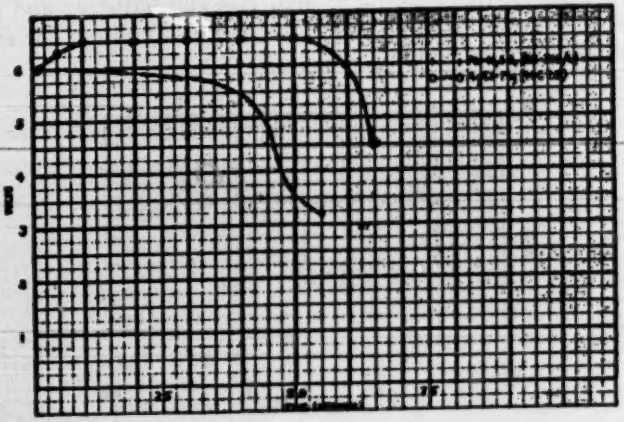

FIG. 6. Comparison of lead-sulfuric acid type battery to silver chloride-Mg type battery. Lead-acid type, 3 cells, type *BB-216/U*; plate area 2.2 sq. in., weight 150 g. Silver chloride-Mg. type, 4 cells, type 4CC25, plate area 40.5 sq. in., weight 70 g.

[fol. 733] shows a typical discharge curve of a 4-cell concentrically wound battery (type 4*CC*200) at a current of about 1.8 amp. This performance was obtained with the battery submerged in sea water. Life is 160 minutes to 1.2 v./cell. Fig. 4 shows a discharge curve of an *A* and *B* battery pack (type 2*MC*40-60*B*3) operating continuously for over 2.5 hours. Operating efficiency of these and other types are summarized in Tables III and IV.

These batteries are characterized by their low weight per ampere-hour or watt-hour output per cell. Fig. 5 shows comparative discharge curves for dry, perchloric acid, and [fol. 734] silver chloride-magnesium batteries for pilot balloon lights showing this feature. Two *AA* dry cells (volume, 0.42 cu. in.; 6.8 cm.^{3}) operated for only 16 minutes to an end point of 1.8 v. The lighter silver chloride battery, type 2*CC*15, operated on the same resistance for 52 minutes to an end point of 2.6 v. The perchloric acid battery, type *BB*-211/*AM*, weighs about twice as much as the 2*CC*15 and gives 76 minutes life on the same load. The steady voltage obtained with the 2*CC*15 is notable. Table I shows the per cent of total life delivered within 90% and 95% of peak voltage and output in ampere minutes/g. for each type.

Fig. 6 shows a similar comparison between a silver chloride-magnesium 6-volt battery (type 4*CC*25) and a 3-cell lead peroxide-sulfuric acid reserve battery; and per cent of life within 90% and 95% of peak voltage for each type is shown in Table I.

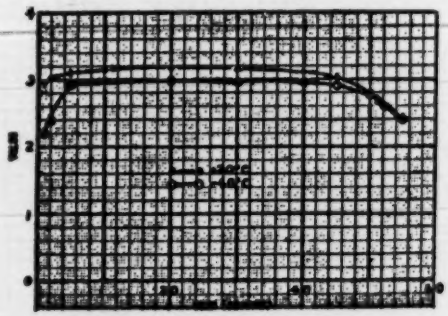

FIG. 7. Effect of temperature on output of AgCl-Mg batteries (2*CC*15). Plate area 24.3 sq. in. Load 10 ohms. Activated at room temperature with tap water for 60 seconds.

TABLE II

Effect of Current Drain on Output

AgCl-Mg cells; Plate area 15 sq. in. (96.6 cm.²).
Activation: Tap Water Continuously.

Load (ohms)	Avg. Current (amp.)	Max. volts	Total Output (ampere-minutes)
20	0.081	1.60	9.3
10	0.165	1.60	9.9
4	0.361	1.60	9.8
1.5	0.927	1.52	9.3
0.4	3.25	1.34	8.2

While these batteries must be activated at temperatures at which water is liquid, once activated they can be operated at much lower temperatures. Fig. 7 shows comparative discharge curves for type 2*CC*15 on 10 ohms load at 20° C and —40° C. The voltage is reduced somewhat but the life is not greatly affected. Similar data for the perchloric [fol. 737] acid type battery, *BB*-211/*AM*, are given in Fig. 8. At —40° C, the action of the battery is stopped after about 20 min. In all of these tests, batteries were activated at 20° C.

TABLE III

Characteristics of Production Type of Batteries

Type	Nominal Voltage	Discharge Current	Minutes Discharge Time to: Specified v.	1.2 v./ Cell	1.0 v./ Cell	Battery Weight: Dry Grams	Wet Grams	Battery Elements Wgt. Dry Grams	Battery Dimensions: W. or Dia.	L.	H.	Amp-hr. Capacity to 1.0 v.
4*MC*96	6.3 v.	1.6 amp.	5.5–60 min.	67 min.	72 min.	190	260	110	2¾ in.	2 in.	3 in.	1.92amp-hr.
4*MC*192	6.3	1.6	5.5–120	134	144	280	400	205	3¼	3¼	3	3.84
4*CC*42	6.3	0.7	5.8– 65	73	75	74	110	74	1¾		3¼[a]	0.875
4*CC*25	6.3	0.5	5.8– 60	64.5	65	60	75	60	1¼		3¼[a]	0.542
4*CC*12	6.3	0.3	5.75–40	46	51	27	35	27	1⅛		1⅝[a]	0.25
3*K*1	3.0	7.0 amp./ flash	1.0– 1	50sec.	55 sec.	15	20	15	2¼ Semi-circular		1¼	0.325
2*CC*15	3.1	0.32	2.9– 55	60	61	20	25	12.5	⅝		2¾[b]	0.33
2*CC*15	3.1	1.00	2.9– 18	19.5	20	20	25	12.5				
2*CC*10	3.1	0.32	2.9– 36	39	39.5	16	20	9	⅞		2⅝[b]	0.21
2*CC*7.5	3.1	0.32	2.9– 28	31.5	32	8	12	8	⅝		2⅜[b]	0.17
2*CC*7.5	2.8	1.08	2.8– 5	6.5	7.5	8	12	8				0.125
1*CC*18*A*	1.55	0.13	1.4– 66	75	78	20	25	20	⅞		1⅝	0.415
1*CC*7.5	1.35	1.10	1.34– 5	7.5	8	3	5	3	⅜		1¼	0.146
4*CC*167	6.0	7.0	4.5– 25	24	25	350	420	350	2⅛		3½	2.92
4*CC*143	5.6	22.0	5.0– 4	5.25	6.25	350	420	219	2⅛		3½	2.29
4*CC*195	6.0	1.6	4.5–120	120	129	904		325	7.65 O.D. 6.5 I.D.		5½	3.44
4*CC*200	6.2	1.8	6.0–120	160	170	724		325	6.0 O.D. 4⅝ I.D.		6	5.10
5*CC*133	7.5	8.0	5.5– 12	14	15	300	350	300	2⅛		3⅝	2.00
2*CC*304	2.8	38.0	2.2– 9	9	9.5	300	360	217	2⅛		2⅝	6.0
2*CC*304	2.8	53.5	2.5– 5	5.5	6	300	360	217	2⅛			5.35
2*CC*245	2.8	38.0	2.6– 7	7.5	8	280	330	186	2⅛		2¼	5.07
18*MC*510	27.0	4.25	24 –120	122	123	2,720	3,200	2,570	5⅝	5⅝	7⅜	8.7
4*MC*40	6.3	0.225	5.5–170	180	182	88	130	80	1¾	4	1	0.682
76*B*4.6	114	0.030	95 –150	160	165	178	240	178	2⅛	4⅝	1¼	0.0823
2*MC*40	3.2	0.200	2.6–150	165	168	30	50	30	2⅝	2⅝	1⅞	0.56
60*B*3	90	0.020	85 –150	165	168	163[c] 119	212[c] 150	149[c] 119				0.084

[a] less socket. [b] with socket.
[c] = total weight of the A and B battery pack.

Type designation.
1st number = number of cells; voltage 1.5 x no. of cells.
CC = concentrically wound cells in series.

[fol. 736]

TABLE IV

Output of Production Type Batteries

Type	Amp-hr. per lb. to Spec. End v.	1.2 v.	1.0 v.	Amp-hr. per lb. of Cell, Wet, Unassembled Spec. End v.	1.2	1.0	Watt-hr./ lb.** to 1 v.	Battery Vol. Cu. In.*	Amp-hr. /Cu. In.	Watt-hr. /Cu. In.
4*MC*96	11.2	12.5	13.4	16.2	18	19.3	20.75	13.05	0.584	0.908
4*MC*192	14.5	16.2	17.4	19.8	20.0	21.5	26.95	31.70	0.485	0.752
4*CC*42	12.5	14.0	14.5				22.50	7.65	0.456	0.708
4*CC*25	12.1	13.0	13.1				20.60	3.99	0.545	0.845
4*CC*12	10.2	11.9	13.0				20.50	1.62	0.616	0.95
2*CC*15	10.7	11.6	11.8	15.3	16.6	16.8	18.80	1.20	0.540	0.836
2*CC*15	10.9	11.6	12.0	15.6	16.6	17.1				
2*CC*10	8.77	9.45	9.55	13.4	14.5	14.7	15.00	1.05	0.40	0.620
2*CC*7.5	11.3	12.7	12.9				20.30	0.435	0.78	1.22
2*CC*7.5	6.8	8.9	9.45				13.3			
1*CC*18*A*	12	14.5	15.0				22.50			
1*CC*7.5	8.27	12.4	13.2				20.5			
4*CC*167	12.6	12.1	12.6				19.85	23.7	0.492	0.764
4*CC*143	6.3	8.3	9.9	9.25	12.0	14.4	13.6	22.9	0.400	0.620
4*CC*195	6.45	6.45	6.9	14.5	14.5	15.6	10.7			
4*CC*200	9.1	12.1	12.8	16.3	21.8	23.1	19.9			
5*CC*133	10.4	12.1	13				19.5			
2*CC*304	14.3	14.3	15.1	18.6	18.6	19.6	21.3	23.7	0.506	0.76
2*CC*304	11.2	12.3	13.5	14.6	16.0	17.5	19.1			
2*CC*245	12.2	13.1	14.0	16.3	17.5	18.7	19.9	14.55	0.696	1.00
18*MC*510	21.6	21.9	22.2	22.8	23	23.3	33.3	212.5	0.740	1.15
4*MC*40	8.9	9.45	9.55				14.6	7.0	0.39	0.605
76*B*4.6	9.45	11.5	11.8				18.4	11.45	0.548	0.853
2*MC*40	9.1	10.0	10.15				15.6 } 13.85	5.25	0.298	0.462
60*B*3	13.6	15.0	15.2				23.5	8.60	0.586	0.910

* There are 16.4 cc. per cu. in.

** There are 0.4536 kg. per lb.

Increase in current has only a slight effect on voltage. Table II presents data for one type of cell at currents from 0.081 to 3.25 amp. Maximum voltage ranges from 1.60 v.

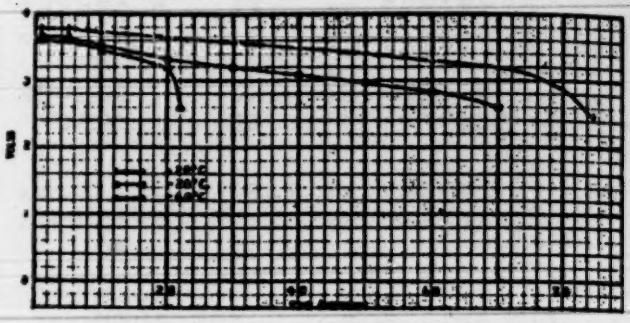

FIG. 8. Effect of temperature on output of lead-perchloric acid batteries. (*BB-211/AM.*) Load, 10 ohms. Electrolyte, 60% $HClO_4$. Activated at room temperature.

at the low current to 1.34 v. at the high. Output in ampere-[fol. 738] minutes is approximately constant except for highest current; but even here the decrease is only 15%.

TABLE V

Comparison with the Average Output of Other Types of Batteries

Type Battery	Amp-hr./ lb.†	Av. Watt-hr./lb.†	Av. Amp.-hr./cu. in.**	Av. Watt-hr./cu. in.**
Lead acid battery				
Range	4.9– 6.5	9.6–11.5	0.44–0.51	0.92–0.99
Av.	5.6	10.5	0.47	0.96
Nickel-iron alkaline battery				
Range	8.6–10.4	10.4–12.6	0.89–0.96	1.07–1.15
Av.	9.6	11.7	0.92	1.11
*Dry cell battery				
Range	1.5–1.65	1.87–2.07		
Av.	1.55	2.0	0.12	0.15
Perchloric acid battery				
Range	6.5– 8.6	8.8–17.1		
Av.	7.5	12.9	0.895	1.7
Silver chloride-magnesium water activated				
Av.	12.9	19.4	0.548	0.854
R. M. battery				
Av.	11.6	13.1	1.37	1.53

* Figure of 150 milliamp, drain taken since comparison is nearer to lower drains on other types of batteries.

** There are 16.4 $cm.^3$ per cu. in.

† There are 0.4536 kg. per lb.

Note: Figure for the secondary batteries and dry cell were obtained from Dr. G. W. Vinal's text on storage batteries and Bureau of Standards CL-677.

Cells used were 0.5 in diameter x 1⅝ in. high (1.27 cm. diam. x 4.13 cm.) with a volume of 0.406 cu. in. (6.7 $cm.^3$) and a weight of 4.5 g.

When protected against excessive humidity, the shelf-life of the batteries is indefinitely long. Batteries manufactured and sealed under the controlled humidity conditions previously described and stored under simulated tropical conditions [45° C (113° F), 95% relative humidty] for one year showed no decrease in voltage and less than 5% change in output.

Tables III and IV give a summary of production type batteries based on results obtained over the past 2.5 years. In Table III the general characteristics are given, while Table IV summarizes the ampere-hour and watt-hour outputs based on weight and volume. In some cases, the design is such that excess space is used in the unit to fit a space. Thus an additional summary of ampere-hour per pound per cell capacity is given to show the ultimate which can be expected on a number of designs.

Table V gives an overall coverage of secondary and primary batteries as compared to the silver chloride-magnesium type. In the case of the dry cell, figures were used at 150 milliamp. drain since this is more nearly in line with the lower drains of most of the batteries summarized. It is shown that the silver chloride-magnesium battery gives greater output per unit weight than the other types but is not as good on a volume basis except in the case of dry cells. However, in general the output per unit weight is an important factor in use of high rate batteries.

Conclusions

Principal advantages of the silver chloride-magnesium battery, which has proved its merit in actual production and field tests during the past few years, are that it is light in weight, small in size, and can be stored indefinitely in hermetically sealed containers without serious loss of capacity. Overall averages of 12.9 amp.-hr. and 19.4 watt-hr./lb. (28.4 amp.-hr./kg. and 43 watt-hr./kg.) of battery on production units and 18.4 amp.-hr. and 22.6 watt-hr./lb. (or 40.5 amp.-hr./kg. and 50 watt-hr./kg.) of cell alone, are obtained.

The battery operates at high terminal voltage under high

and low discharge rates. The data presented show that for low rates, from 10 milliamp. to 10 amperes, the voltage per cell is maintained at 1.50 to 1.55 v. From 10 to 50 amp., the voltage is maintained between 1.42 and 1.50 v. Change in ambient temperature has little effect on output. The discharge voltage remains flat over the major portion of the discharge.

A further advantage of the battery is that a special electrolyte is not required for its operation because it operates with any type of water (either fresh or salt). It therefore is not necessary to handle or store a special electrolyte.

[fol. 739] Resumen del artículo: "Características de la Pila de Magnesio y Cloruro de Plata."

Durante la guerra se necesitaba una pila con voltaje elevado, poco peso por unidad de energía eléctrica, y habilidad de almacenarse largo tiempo y de rendir una corriente grante. Se estudió la combinación de Mg y AgCl por su voltaje elevado y excellente acción depolarizante. Esta pila se forma de una hoja de Ag con una capa de AgCl depositada electrolíticamente, una hoja de papel secante, y una hoja de Mg puro comercial. Para corrientes elevadas se arrollan las hojas, formando un cilindro con la superficie de electrodos deseada. Para voltajes elevados se emplea un montón de rectángulos pequeños, con AgCl en un lado sólo de los electrodos de Ag. Se fabrican las pilas en una atmósfera seca y se encierran en paquetes impermeables. Para emplearse, sólo se ha de mojar la pila con agua salada, agua de mar, o también agua potable.

Al descargarse la pila se mantiene el voltaje más constante que en otras clases de pilas (Fig. 1). Una pila de sólo 3.5 cm. de diámetro y 6.7 cm. de longitud produce 100 amperios a 1.4 voltios por un minuto y medio. El rendimiento en amperios-minutos per gramo de la pila es mayor que en otros tipos de pilas (Tabla I), y no varía mucho al descargarse la pila en 3 minutos o en 2 horas (Tabla II).

Discussion

George W. Vinal[2]: I notice in one curve (Fig. 8) the perchloric acid did not show up so well at low temperature,

[2] National Bureau of Standards, Washington, D. C.

but the concentration of the electrolyte was 60%. I think if you reduce the concentration slightly, performance would be better.

J. B. MULLEN: That is correct, but I might say that in every case these data were obtained on production models and not on laboratory batteries. The production batteries were made with that 60% concentration. These batteries, as well as the silver chloride batteries, were made by ourselves.

H. E. HARING[3]: Congratulations are in order—to government agencies and manufacturers for the progress which has been made in battery development during the war years, and to the Chairman of this symposium for his success in promoting an extremely interesting program. I will take the liberty to express a few thoughts on batteries in general before commenting briefly on the paper by Messrs. Mullen and Howard.

The electromotive force series contains only a limited number of metals, non-metals and compounds which are physically, chemically and economically suitable for use as battery electrodes. Numerous investigators have attempted to develop new batteries from this abbreviated list. In consequence it is difficult to suggest a practicable combination of electrodes which has not been used before and almost impossible to suggest an individual electrode which has not been at least considered. Electrode combinations are suggested, possibly patented, even used to a limited extent—and then forgotten. Frequently these same or similar combinations are re-discovered at some later date. A recent survey of the literature indicates that, although more than a hundred combinations of electrodes and electrolytes have been proposed, constructed and tested as finished cells, only about half a dozen are in commercial use today. Why [fol. 740] is this so? Why is the mortality rate for new born batteries so large? Something must be lacking in those cells which do not "make the grade."

I am of the opinion that this "something" usually is "electrochemical design." Too often there is a tendency to select or "discover" certain electrodes, settle on some convenient mechanical design and hope that the resulting

[3] (Illegible) Bell Telephone Laboratories Inc., Murray Hill, N. J.

cell will perform efficiently. Sometimes it does, usually it does not. I am discussing this subject in some detail because I am firmly convinced that the only way in which real progress can be made in future battery development is through a more thorough application of electrochemical principles. *Batteries must be designed primarily on the basis of what is right electrochemically—not what is easy mechanically.* Actual experience indicates that surprising results can be obtained by strict adherence to this philosophy.

Silver chloride, according to the patent literature, was employed extensively in the latter part of the last century as the positive electrode of batteries used for ringing doorbells and lighting gas lamps. The numerous references to the doorbell application suggests that ringing of doorbells was a popular pastime. Zinc was employed as the negative electrode, because it was the best metal available for the purpose at the time. Magnesium has always been attractive to battery designers because it yields at least 0.5 volt more than zinc, is lighter in weight and has a much more favorable electrochemical equivalent. It is not surprising, therefore, that, as soon as it became commercially available, magnesium was used in a number of primary cells in conjunction with a variety of positive electrode materials.

The data presented by Messrs. Mullen and Howard indicate that the "roll-up" type of silver chloride-magnesium battery is superior to many other kinds of battery for certain low-power, short-time applications. Scrutiny of this design, however, indicates that this restricted sphere of usefulness could have been broadened materially by closer adherence to basic principles of electrochemical design. design. Stated briefly these principles are: (1) the ratio of available electrolyte to active material should be sufficiently large to permit maximum operating efficiency; (2) the ratio of active material to structural material should be as large as possible, particularly if a maximum output per unit of weight or volume is desired.

The use of an absorbent paper separator, as described by Messrs. Mullen and Howard, not only restricts the volume of electrolyte which can be made available but also stagnates it. In consequence, (a) corrosion products accumulate very rapidly and in the wrong place, *i.e.*, on the surface of the magnesium; (b) the copious quantities of hy-

drogen gas which are liberated when magnesium functions as an anode tend to be trapped in the cell structure; and (c) excessive heating results. The first two of these effects increase polarization and internal resistance and all three combine to necessitate the use of much lower current densities than otherwise would be necessary. In electrolytic processes in general, electrolyte mobility should be enhanced, not restricted.

Departure from the second principle is to an extent forced by departure from the first. In order to operate at a lower current density and still produce the same total current, it is necessary to provide a larger area of active material and to spread it upon a more extensive structural base. Since the foil used in the "roll-up" type of construction cannot be reduced beyond a certain minimum thickness, a more unfavorable ratio of active material to structural material is obtained than otherwise would be necessary. Extension of the length of the foil electrodes also increases the internal resistance of the cell and imposes a further limit on the current density which can be employed without causing over-heating and non-uniform current distribution.

The discharge curves presented in the paper indicate a "come-up" time which is much too slow for many applications. It should be possible to improve this situation by slight modifications based on electrochemical principles.

These comments are intended as an illustration of the manner in which a design is extremely enticing from the standpoint of mechanical construction can impose handicaps of an electrochemical nature which cannot possibly be overcome if it is desired to extend the usefulness of the cell.

The foregoing remarks could have been made solely on the basis of electrochemical considerations. Actually, however, they were influenced in large part by personal experience. It is now permissible to state that during the war [fol. 741] years the Bell Telephone Laboratories developed magnesium/sea-water/silver chloride batteries which differ radically from all other types of primary battery. Conceived at the laboratories prior to the war, this project subsequently was endorsed by the National Defense Research Committee and in cooperation with the Navy intensively pushed to a highly successful conclusion. A variety of models went into quantity production ranging

in weight from one ounce to several hundred pounds. It is hoped that official approval can be secured for the further disclosure of this development at a future meeting of the Society.

P. L. Howard: Your general observations seem to be well founded. Too often in the past the couples have been discarded, due to disregard for electrochemical principles and design. However, a great deal of credit must be given the government and the manufacturers for their ingenuity in making practical some of these couples for war use.

By virtue of the pressure during the war years, these couples could not always conform to electrochemical principles; however, sufficient electrochemical principles were followed to make them practical from a manufacturing standpoint. These include the perchloric acid battery, the silver oxide battery, the mercury cell, and the various designs of the silver chloride water activated battery. Other couples were worked upon and a practical design reached at the end of the war.

All of these types may be considered in the embryo stage. When a practical design was made during the war, this was immediately translated into a production item even though complete efficiency and design under full electrochemical principles were not realized. However, sufficient gain was made in the relation of space and output per unit weight over conventional types of batteries that such sacrifice was merited for war applications.

With reference to the paper at hand and your comments on the restricted sphere of usefulness by virtue of our particular design, the silver magnesium battery is based on electrochemical principles. However, the pressure for production of the unit as originally designed greatly retarded the full development of this couple during the war. Relatively wide application of this unit was made for airborne units, i.e., units which were to be used out of water; the minimum space and weight necessarily were to be obtained by the use of such an absorbent paper for retention of the electrolyte in the cell. For example, the type 2CC15 unit requires a minimum space and weight. As shown in the paper, the space and weight of a unit (BB-211/AM) containing a separate electrolyte was practically double that required for the water activated unit. In the 2CC15 the paper weighed 2.24 g. and absorbed 5.5 g. of water.

In the actual electrochemical reaction the water acts merely as a conductive agent. The limiting effect as to quantity of water is in the amounts evaporating, hydrating the magnesium salt, and consumed as local action. The battery is designed and tested to meet these needs. About 75% of the water is used in the 2CC15. Thus, it was not expedient or practical to use conventional designs of free electrolyte cells. In all such designs sufficient electrolyte has been made available to completely utilize the silver chloride. From the flatness of the discharge curves, it is seen that this is true. The hydrogen evolved from the magnesium tends to relieve the accumulation of corrosion products at the magnesium surface and freely removes itself from the cell. The matter of excess heating results primarily from the local action feature of the magnesium and water. We have found that the corrosion products from the magnesium are very well dispersed throughout the paper and do not cause undue blocking of the magnesium surface.

Since the battery design is based upon obtaining a battery which will deliver 1½ volts per cell under all discharge conditions, the current density appears to be low. In certain applications which we are presently working upon, the current density is much greater and the voltage is allowed to stabilize at approximately 1.25 volts. In the past, conventional types of batteries had a ratio of approximately 40% to 50% of the total weight of the plate as the inert grid structure. With our foil construction, the plate is etched to such a point that a maximum of approximately 30% base metal is left. Thus, we have gained considerably on the ratio of active material to grid structure.

In order to cut down internal resistance, the unit is not constructed of a single foil of increased length for greater [fol. 742] output but is made up of a multiplicity of shorter plates so that the internal resistance of the cell may be kept at a low figure throughout the range of current densities. It is known that one submerged design of a 24 volt battery which you made for a particular application was superior to the design which we made using paper. This is by virtue of free electrolyte passage used in your particular design. However, it is also known that there are complications and difficulties involved in the design of a battery to use free electrolyte in the form of means of forcing the electrolyte between the plates sufficiently fast to remove the

discharge products and also baffling to cut down leakage currents in submerged operations.

The reference to slow "come up" time is a structural design. In general the cases cited are with pure water; however, if salt water is used, this time is greatly reduced. For the particular applications for which these batteries were intended, this period, of time is immaterial. In certain applications we have especially designed batteries to have a shorter "come up" time. In fact, they have been designed to blow high amperage fuses in from 2 to 5 seconds as the case may require. Thus, summing it up, the unit which we have designed is applicable to a wide range of applications where the requirement is for minimum space and weight without the units being submerged in water at all times. This is in contradistinction to the types which you have considered where they are submerged at all times.

We all know there is a great deal of work to be done on this couple to reach the ultimate aim based particularly on electrochemical principles. This has been retarded by virtue of the urgent demand for batteries showing any decided improvement over conventional types for military purposes. Thus, both designs have been limited in their scope due to wartime pressure. You deserve a great deal of credit for the development work which you have carried out on this type of battery for wartime use.

J. B. MULLEN: We are in accord with Mr. Haring's comments on the application of electrochemical principles to battery design. The fundamental principles he states will permit most effective utilization of space and most efficient performance.

In manufacturing batteries, however, the factor of cost must also be considered. Even with costly materials such as silver, the labor cost is often a predominantly large component of the manufacturing cost. Therefore, a simple method of assembly which reduces manufacturing cost is not necessarily a point of criticism even if other methods of construction would permit greater efficiency on a weight or volume basis.

A suitable ratio of available electrolyte to active material must be provided to manufacture any successful battery. The ultimate product of the cell reaction in the silver chloride-magnesium battery is magnesium chloride, which

takes up a considerable amount of water of hydration and thereby removes a large part of the water from the field of action. Therefore, it is most essential that an adequate amount of electrolyte be present initially. This is controlled by using a highly absorbent paper of optimum thickness, and in some cases by providing additional free spaces for retention of water in the cell.

The paper used is highly absorbent. The interelectrode space in these cells retains approximately 0.8 gram of water per cubic centimeter of paper. The diminution of electrolyte volume by the presence of the paper is not great, percentage-wise.

The use of an absorbent paper layer does stagnate the electrolyte and interfere with free circulation. Free circulation is certainly desirable. In practice, however, the quantity of corrosion products accumulated on the plates is not large enough to interfere with the operation of the cell to any marked degree. This is attested by the constant voltage delivered.

The presence of the paper limits current density somewhat; nevertheless, current densities as high as 70 amp./sq. ft. (7.5 amp./dm.^{2}) can be obtained at a terminal voltage of 1.4 volts per cell or higher. To obtain a good terminal voltage at such current densities, it is necessary to provide internal conductors of adequate size to carry the current without excessive voltage drop. This can be accomplished by using additional lead wires which at the same time permits reduction of the length of the foil strips. [fol. 743] The build-up time is comprised of the time required to saturate the paper layer and the time required to build up the concentration of the electrolyte which initially is poorly conductive when tap water is used. Tap water is used chiefly as a matter of convenience and is not necessarily the preferred electrolyte for all applications. To achieve a faster build-up time, a more conductive electrolyte can be used initially; wetting agents may be added to speed up saturation, and vacuum or pressure used to promote rapid absorption. Build-up to full voltage within a few seconds can be obtained by use of these methods.

In some applications, other types of batteries might be preferred to silver chloride-magnesium batteries, if only from the standpoint of cost, and there are undoubtedly applications in which the particular characteristics of the

spiral wound construction might make a different form of silver chloride-magnesium battery more advantageous. However, there are many applications in which the construction described in this article has been found practical and efficient and capable of outperforming the other types of batteries that were tested.

U. B. THOMAS, JR.[3]: I think the come-up time that Mr. Haring was referring to was of the order of 10ths of seconds, as compared to the several seconds on these curves.

COLIN G. FINK[4]: Would sunlight have any effect on the silver chloride layer?

J. P. MULLEN: The silver chloride layer as formed has a purplish cast. The color changes appreciably if it is left exposed to sunlight, but the weight does not change within the limits of the precision of our analysis.

U. B. THOMAS: Very fortunately, the sunlight converts the silver chloride to highly reflecting silver, which quickly covers the surface so that no more sunlight can penetrate below the surface.

C. G. FINK: So silver chloride can continue to act as a depolarizer.

A. L. FERGUSON[5]: I did not get the statement as to what was used as the porous material.

J. P. MULLEN: It is just absorbent paper.

A. L. FERGUSON: You mean that there was nothing there but paper?

J. P. MULLEN: That is right; there may be a wetting agent in the paper but good results are obtained without it.

A. L. FERGUSON: You mean that the cell will work if you put it in distilled water?

J. P. MULLEN: Yes, it will. We will send you some cells to try.

M. LANG[6]: Has there been evidence of moisture pick-up in high humidity?

J. P. MULLEN: Yes. In high humidity the batteries become activated. The normal procedure is to store them in double-tite cans or in hermetically sealed apparatus until it is desired to use them. The exact procedure is

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[3] Bell Telephone Labs., Murray Hill, N. J.
[4] Columbia University, New York 27, N. Y.
[5] University of Michigan, Ann Arbor, Mich.
[6] U. S. Electric Mfg. Corp., New York City.

adapted to the application but the containers are sealed until the batteries are used. We have some batteries that have been in storage for a couple of years and they have not deteriorated.

[fol. 743a] A paper presented at the Ninetieth General Meeting held at Toronto, Canada, October 19, 1946, George W. Vinal presiding.

Dry Cell Dynamics: The Bobbin [1]

By J. J. Coleman [2]

Abstract

This paper is a study of the relation between ampere-hour capacity and drain. To determine this relation, a simplified model of the bobbin is set up. Kirchhoff's law is applied to this model to determine how the current through the manganese particles is distributed. (Do the particles near the carbon, or near the edge of the core, or somewhere between, bear the heaviest load?) It is demonstrated that on light and moderate loads the current is distributed almost uniformly, *i.e.*, each manganese particle suffers about the same "drain." Attention is then focused on the individual particle. Evidence is introduced which indicates that some diffusion process within the particle itself plays a dominant role in determining the behavior of a dry cell on moderate and light loads. Fick's law of diffusion is applied to this hypothetical process. Constant current tests are used to determine the parameters in the resulting equations and to determine their ability to describe the behavior of dry cells on these tests.

I. Introduction

It is the objective of this paper to establish a mechanical picture of the bobbin of a dry cell which will show how it works as a machine transforming chemical energy into electrical energy. Most of the paper is directed toward the calculation of capacities from the principles of physics.

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[1] Manuscript received July 25, 1946.

[2] Burgess Battery Company, Freeport, Ill.

In itself, this is trivial. One can not compete with a test laboratory. The reader is asked to bear in mind that the ultimate objective is the establishing of some picture, even a crude one, of the mechanism of the dry cell which will make some of its idiosyncracies intelligible to engineers trying to mold its behavior to the needs of commerce.

Any complete picture must take into account the interaction of zinc and paste. This receives only cursory mention here, and will perhaps be the subject of a subsequent paper.

[fol. 744] IN THE UNITED STATES COURT OF CLAIMS

PLAINTIFFS' EXHIBIT No. 40

UNITED STATES PATENT OFFICE

2,817,697

Patented Dec. 24, 1957

1

2,817,697

CUPROUS CHLORIDE MAGNESIUM BATTERY

Melvin F. Chubb, Joplin, Mo., assignor to The Eagle-Picher Company, Cincinnati, Ohio, a corporation of Ohio

Application April 6, 1954, Serial No. 421,424

8 Claims. (Cl. 136—91)

This invention relates to a method of preventing overheating in cuprous chloride magnesium batteries. At present, batteries of this type are being manufactured in large quantities for a variety of purposes, for instance, weather balloons, and have the advantage over other known batteries of providing a large output of electrical energy in relation to the weight of the battery

It is customary to manufacture these batteries in dry condition, i.e., with no electrolyte present, then activate the batteries by immersion in water immediately prior to use. The common type of cuprous chloride magnesium cell comprises a mass of porous cuprous chloride deposited on or secured to a metal screen as a positive electrode, a thin sheet of magnesium as a negative elec-

trode, and a bibulous cell separator between the two electrodes, the cell separator being adapted to hold a predetermined amount of water as electrolyte. Such a battery produces current until one or the other of the active electrode chemicals is substantially consumed or until the electrolyte freezes or boils off.

The batteries of the present invention are particularly adapted for use on airborne equipment, weather observation balloons, etc., because of the relatively large amount of electrical power produced by such batteries in relation to their weight. However, at high altitudes the temperature is very low, thereby tending to freeze the electrolyte (water), and the pressure is much reduced, thereby increasing the tendency of the electrolyte to boil off. The objective or the ideal of the battery designer is to coordinate and proportion the elements which constitute the battery in such manner that the electrolyte does not boil off before the active chemicals of the electrodes are exhausted, yet to maintain the intensity of the chemical reactions at a level to produce enough heat to keep the electrolyte from freezing. Ultimately, if the active chemicals of the electrodes or either of them are exhausted before the electrolyte boils off, the electrolyte will freeze at low temperature.

The object of the present invention is to provide a method of preventing the electrolyte in a battery of the type in question from boiling off prior to chemical exhaustion but without impairing the efficiency of the battery from the point of view of producing electrical power. Otherwise stated, it is an object of this invention to provide a battery of the cuprous chloride-magnesium-water type which has a longer useful life than the batteries of this type heretofore provided.

The exact nature of the complex chemical current-producing reactions of this type of cell is not known in any substantial detail and much of the development has necessarily depended upon the employment of purely empirical methods. These batteries are "one-shot batteries" in that, after once being activated by the electrolyte, the physical and chemical disintegration of the positive electrode proceeds regardless of whether the circuit is opened or closed and the use of the batteries is therefore limited to purposes where a heavy continuous current

for a limited period, such as several hours, is required. The recharging of such batteries is not possible, at least at present.

The general type of battery structure to which this invention is directed is disclosed in the patent to Fischbach et al., No. 2,636,060, issued April 21, 1953, and in the patent to Pucher et al., No. 2,640,090, issued May 26, 1953. Both of these patents disclose batteries which utilize the same chemical system as the batteries of this invention and also disclose battery structures to which the present invention may be applied.

* * * * * * *

No detailed theory can be offered as to why small quantities of cadmium chloride in the electrolyte tend to reduce overheating; but the tests indicate that when a battery of the type in question is activated, a great number of complex chemical reactions is initiated. Some of these reactions are directly responsible for the generation of electric current, but others, which may be termed "side reactions," generate heat without contributing to the overall electrical output of the battery. It is believed

that in the complex electrolyte solution constituted by the interaction of cuprous chloride, magnesium and water, the cadmium of the cadmium chloride tends to precipitate at the magnesium electrode, thereby reducing the rate of its chemical activity and particularly retarding the side reactions which produce heat rather than electrical current. Nevertheless, the present invention is based primarily upon the empirical determination that the presence of a small percentage of cadmium chloride in a cell of this type reduces the tendency of the cell to oveheat without correspondingly reducing the electrical output of the cell.

As an example of the efficacy of the present invention two batteries were given similar tests under similar conditions, the tests being carried out at a temperature of —60° F. The batteries were alike except for the fact

that electrode separators of one battery were coated with enough cadmium chloride to provide a concentration of electrolyte of the order indicated. The minimum required voltage of these batteries was 95 volts. The battery without the cadmium chloride developed the minimum required voltage 11 minutes after dunking in water. The maximum voltage reached was 118 volts. The battery operated at or above the required minimum voltage for 136 minutes at the end of which time the electrolyte had boiled off, so that the battery was hot and dried out. The similar battery containing the cadmium chloride required 20 minutes to reach the minimum required voltage of 95 volts. This battery reached a maximum voltage of 116 volts and operated at a voltage at or above required minimum voltage for 192 minutes. By the end of this period the chemical reaction had decreased to such a point that the electrolyte froze. The first battery provided the electrical power which it was designed to give for a period of 2 hours and 16 minutes, whereas the second battery, which contained the cadmium chloride, operated as required for 3 hours and 16 minutes.

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[fol. 746] IN THE UNITED STATES COURT OF CLAIMS

PLAINTIFFS' EXHIBIT No. 41

UNITED STATES PATENT OFFICE

2,745,893

Patented May 15, 1956

1

2,745,893

CUPROUS CHLORIDE MAGNESIUM CELL WITH CELLOPHANE MEMBRANE

Melvin F. Chubb and James M. Dines, Joplin, Mo., assignors to The Eagle-Picher Company, Cincinnati, Ohio, a corporation of Ohio

Application April 23, 1952, Serial No. 283,938

2 Claims. (Cl. 136—100)

This invention relates to cuprous chloride magnesium cells in which water or an aqueous solution is used as the electrolyte and in which a pad of bibulous material is employed for retaining the electrolyte in engagement with the electrodes of the cell. The invention is particularly applicable to a cell in which the positive electrode is constituted by a mass of pulverant cuprous chloride pasted to a screen or grid. This type of cell is activated with electrolyte just prior to time of use and is adapted to discharge a useful current for a period of substantially four to six hours after activation. In general, it is necessary to activate the cell anywhere from a few minutes to half an hour prior to actual use in order to permit a build up of magnesium salt in the electrolyte and the action of the electrolyte disintegrates the pasted positive physically regardless of whether the circuit is closed or not.

After the cell or battery has been activated by aqueous electrolyte and circuit closed, an electrochemical process involving the material of the positive electrode com-

mences, so that the positive electrode is disintegrated by both physical and electrochemical forces. The use of a limited quantity of electrolyte, which is immobilized by the bibulous pad which carries it, has the advantage of minimizing the rate of physical disintegration of the positive electrode without impairing the electrolytic action. But the disadvantage of this arrangement is that various copper compounds become deposited within the fiber structure of the bibulous pad and tend to short circuit the cell. These deposits or filaments of copper compounds start to form from the magnesium electrode side of the cell and, while not pure copper, seem to have enough current carrying capacity to impair the output of the cell through the external circuit. If the deposits build up to a true short circuit, then the remainder of the chemicals which constitute the electrodes is exhausted by electrochemical action without any useful result in the external circuit. This forming of short circuits is most apt to occur during the latter half of the period of discharge of a cuprous chloride magnesium cell.

The object of the present invention is to provide a cell of the type described which delivers useful current until one or both of the materials of the electrodes are exhausted.

We have discovered and determined that this result is attained by disposing a relatively dense membrane such as regenerated viscose, i.e., cellophane, between the two electrodes preferably intermediate the layers of the bibulous pad which holds the electrolyte. The reason for the efficacy of this relatively simple expedient is not easily explained, but the benefit and value has been determined empirically.

From the point of view of theory, cuprous chloride is relatively insoluble in water, whereas cupric chloride is relatively soluble. In the presence of water, cuprous chloride tends to convert to cupric chloride and copper or to complex copper salts and hydrates. Since the cell of the type in question produces a current which is rela-

tively large in relation to the weight of the materials which constitute the electrodes, it must be assumed that

the cuprous chloride of the positive electrode is dissolved in the electrolyte to a degree substantially greater than it would be if it remained as cuprous chloride. The cuprous chloride magnesium cells which utilize porous or pasted positive electrodes generate substantial heat in operation, and this heat accelerates the conversion and disintegration of the positive electrode.

In any event, magnesium chloride is formed at the negative electrode after the circuit is closed and, in theory, all of the copper should wind up at the positive electrode, or otherwise expressed, the cuprous chloride of the positive electrode should be reduced to metallic copper. In practice, however, the reactions do not correspond to any simple theory and copper compounds are deposited in the bibulous pad between the positive and negative electrodes. In some cases, the copper seems to foul up the magnesium negative electrode and in other cases the copper compound seems to plate out in filaments through the bibulous pad, thereby tending to produce short circuiting during the latter part of the life of the cell. In fact, a cell may go dead on this account before the useful life of the chemicals which constitute the electrode is exhausted.

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[fol. 747] IN THE UNITED STATES COURT OF CLAIMS

PLAINTIFFS' EXHIBIT No. 42

PRIMARY BATTERIES

George Wood Vinal, Sc.D.
Physicist, National Bureau of Standards

New York · John Wiley & Sons, Inc.
London · Chapman & Hall, Limited

[fol. 748]

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By

George Wood Vinal

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[fol. 749] 1

Historical Introduction

A new era in electrical experimentation began with the year 1800. Alessandro Volta (1745-1827), professor of natural philosophy in the University of Pavia, Italy, communicated his epoch-making discovery of the voltaic pile and crown of cups to the Royal Society of London in a letter [1] addressed to the Rt. Hon. Sir Joseph Banks, dated March 20, 1800. This letter was read to the Society on June 26 of the same year. In addressing Sir Joseph, Volta said: "The apparatus of which I speak to you and which will astonish you without doubt is only an assemblage of a number of good conductors of different kinds arranged in a certain manner." Volta's "letter," amounting to 28 printed pages, describes with remarkable clarity how he constructed his famous pile and crown of cups and the many experiments which he made with his apparatus.

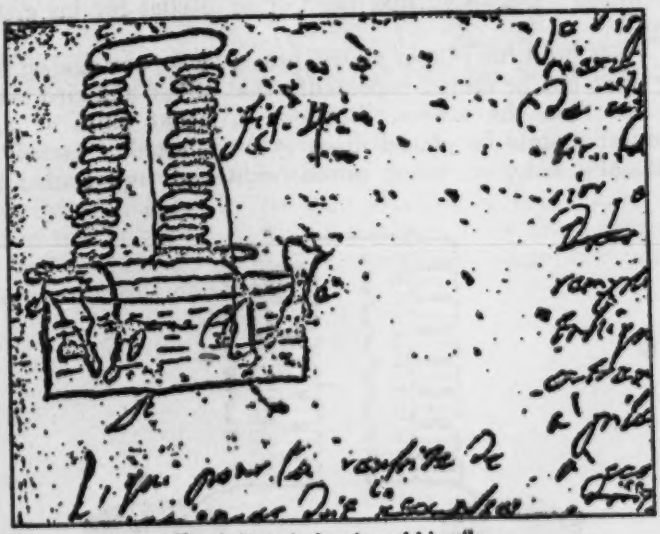


Fig. 1. Volta's drawing of his pile.

[1] Alessandro Volta, On the electricity excited by the mere contact of conducting substances of different kinds, *Phil. Trans. Roy. Soc.*, 90, 403 (1800). In French.

Volta knew that the effects produced were greater when he employed a larger number of couples. He mentions 30, 40, and 60 couples, and in another part of the paper he says that he made the pile "as high as would sustain itself without falling down." He judged the strength of the electric current often by the sensations which he experienced on touching the terminals, but he was not entirely dependent on the sensation of pain. As early as 1782 he had communicated to the Royal Society a paper on a method of detecting minute quantities of electricity. Elec- [fol. 750] troscopes were known at the time and had been used previously.

In terms of modern concepts, he recognized the increased electromotive force of a larger number of couples and he knew that moistening the skin improved conduction. Without knowing any formal relationship, he may perhaps have had a vague intimation of the forthcoming fundamental law which Georg Simon Ohm (1787-1854) revealed to an incredulous public in 1827. Years passed before Ohm was accorded recognition and the Copley Medal for his great work.

Volta built his pile of silver, brass, or copper against tin or zinc, but he stated repeatedly that silver and zinc were better than the others. Between adjacent pairs of dissimilar metals he placed discs of pasteboard ("*carton*"), animal's hide, or other porous material well soaked in

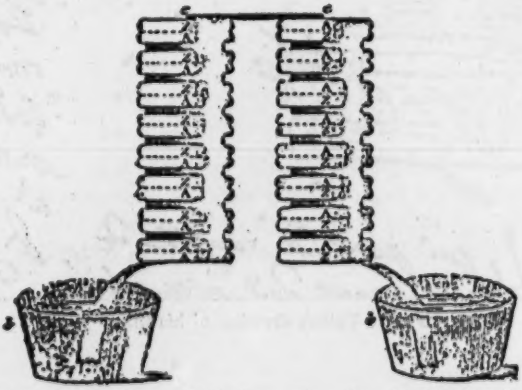


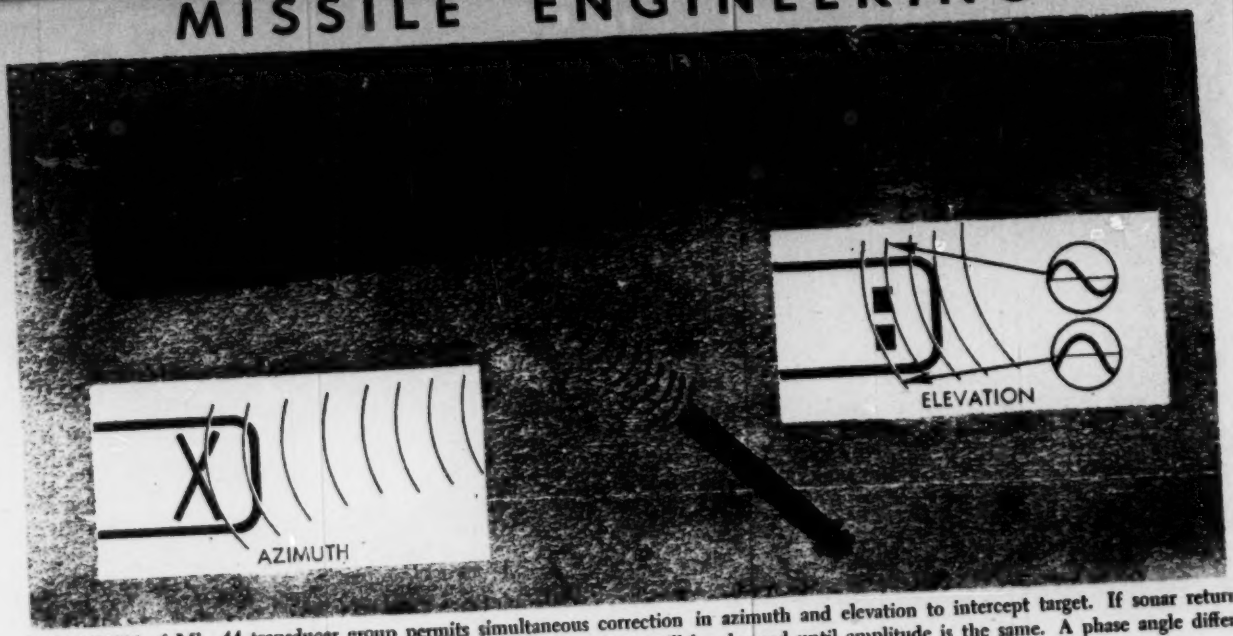
FIG. 2. Volta's pile. From *Phil. Trans. Roy. Soc.*, 90 (1800). *A* stands for argent (silver) and *Z* for zinc.

water or "some other fluid which may be a better conductor than simple water, as salt water, lye, etc." Volta's own drawing of his pile (Fig. 1) was reproduced from his notes for the Lombard Royal Institute of Letters and Science and presented as a souvenir to the members of the [fol. 751] International Electrotechnical Commission meeting in Milan in 1927. More conventional drawings of the pile and the crown of cups as they appeared in the *Transactions of the Royal Society* for the year 1800 are shown in Figs. 2 and 3.

The crown of cups (Fig. 3) was another development described in the letter from Volta to Sir Joseph Banks. It is perhaps less famous than the pile, but Volta evidently regarded it as a more effective source of electricity, because the supply of electric current did not fail as a result of dryness, whereas it did fail in the pile.

FIG. 3. Volta's crown of cups. From *Phil. Trans. Roy. Soc.*, 90 (1800).

The elements of the crown of cups were the same as for the pile. Volta employed many cups, comparable to the number of couples in his pile. Evidently there were so many that he placed them in a circle to bring the terminals near together. From this arrangement came the name crown or circle of cups.



OPERATION of Mk. 44 transducer group permits simultaneous correction in azimuth and elevation to intercept target. If sonar return strikes one set of transducers more directly than the other, direction will be changed until amplitude is the same. A phase angle difference is produced when the signal strikes one set of transducers before the other, indicating a depth error.

Navy Orders Homing Torpedo Production

Washington—Navy has ordered the General Electric-developed Mk. 44 active homing torpedo into production after a two-year evaluation, and the weapon will be used by the fleet against high performance nuclear submarines.

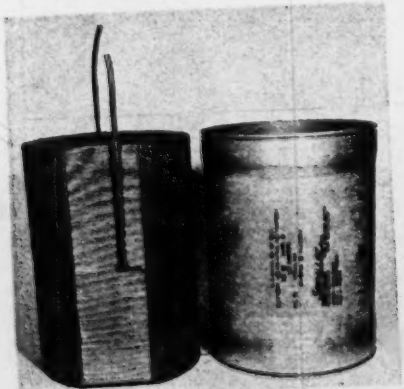
Mk. 44 torpedo is the conventional payload for the Asroc anti-submarine missile system (AW June 27, p. 32). It can also be dropped from attack aircraft and fired from existing surface shipboard torpedo tubes. Mk. 44 has been under development by GE Ordnance Dept. since 1954.

Mk. 44 is 100 in. long and one foot in diameter. Original thermal drive was scrapped in favor of electric propulsion when GE Ordnance developed the high power Mk. 61 salt water battery. Electric power was found to be superior to steam in reliability, power-to-weight ratio and handling ease with the new battery. Silver chloride and magnesium battery plates are dormant until activated by sea water. Storage lifetime is said to be unlimited, with no requirement for recharging.

Active acoustic homer located in the nose section is a miniature low-frequency sonar with sound-to-electric transducer groups. When a target ping is returned, transducers establish azimuth and elevation errors, take the torpedo out of its circling search and aim it on a direct path to the submarine.

Because Mk. 44 operates at high speed, design of shell, propellers, fins and shroud rings were hydrodynamically integrated to prevent cavitation from jamming the acoustic homer.

Afterbody shell is lightweight aluminum. This metal is more resistant to salt air than magnesium, which also was tested. With aluminum, Mk.



U. S. COURT OF CLAIMS
Adams
vs. U. S. No. 163-60
PLTF DEFT Exh. No. 43

SILVER CHLORIDE and magnesium plates are used in the Mk. 61 sea water battery (at left) to power the Mk. 44 torpedo electric drive. Battery does not require recharging during long storage life. GE says that it has a higher power-to-size ratio than other marine batteries. The Mk. 44 torpedo (right) is 100 in. long and one foot in diameter. Homer and guidance are in the nose section. Warhead is in the center, and the afterbody contains batteries and gear box. Slots in forward section are for nose fairing in Asroc application. Airframe and booster clamp on to the afterbody when the torpedo is rocket-launched.

503

[fol. 753] IN THE UNITED STATES COURT OF CLAIMS
DEFENDANT'S EXHIBIT No. 1

ELEMENTARY TREATISE

ELECTRIC BATTERIES

From the French of
Alfred Niaudet
Membre de L'Academie des Sciences

Translated by
L. M. Fishback
of the Bell Telephone Co. of Missouri

New York:
John Wiley & Sons
15 Astor Place
1880

[fol. 754]

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Acid Batteries

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Chloride Batteries

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[fol. 755]

Chapter VII

Chloride Batteries

The depolarization of the conducting electrode is generally effected by oxygen, but it can also be done by chlorine, as will be seen in the batteries which we will now describe.

Chloride-of-Platinum Battery

We only mention this battery, not admitted in practice, because Daniell points it out as a model of a perfect battery. After having described his sulphate-of-copper battery, he adds:

"The surface of the conducting electrode is thus perpetually renewed by the deposit of pure copper, and the contrary action of the zinc and of every other metal precipitated is successfully prevented. The affinity of the copper for the acid, though less, exists, however, and this opposition could not be prevented except by the use of platinum electrodes, whose surface would be continually renewed by the decomposition of chloride of platinum; this apparatus would be perfect, but very costly. . . ."

It is probable that Daniell intended the cell to be composed as follows: zinc, dilute sulphuric acid; chloride of platinum, platinum.

Under these conditions, the depolarization would be effected as in the Daniell cell, only that the hydrogen would be burnt by the chlorine instead of by the oxygen. [fol. 756] The principal action of the battery would still be that of the sulphuric acid upon the zinc, and the decomposition of the chloride of platinum would be less of an obstacle to the principal action than that of the sulphate of copper in the Daniell. The electro-motive force of the chloride-of-platinum battery ought to be much greater than that of the sulphate-of-copper battery.

Chloride-of-Silver Battery

Marié Davy appears to have been among the first to employ chloride of silver. In 1860 he wrote the following:

"I have constructed a battery formed of zinc, pure water, and chloride of silver melted in a silver crucible, and it has worked with perfect regularity. Its internal resistance, at first very great, has gradually diminished in proportion

as the chloride of zinc formed has been dissolved in the water. By previously dissolving this salt, the battery immediately furnishes a strong current. The chloride of silver is completely reduced throughout all its parts, always preserving its shape. The insolubility of the reducible salt becomes an advantage, as it dispenses with the use of porous jars. . . ."

During the same year we studied this battery, using a porous jar and undissolved chloride of silver; our electrodes were of copper and amalgamated zinc. We found the electro-motive force to be apparently equal to that of the Daniell.

These experiments possess in themselves but little interest. It is only since Warren De La Rue has given his attention to this battery that it has attained any importance, and that its use has become general.

[fol. 757] In the beginning of his researches, this physicist used chloride of silver in the shape of a powder or paste, and his liquid was a thin solution of sea-salt. A little inconvenience in this battery has been pointed out to us. It appears that it evolves gas, and that, consequently, if the glass jar be hermetically closed the pressure of the gas causes it to burst.

It is clear that this gas is only an inconvenience when the jars are tightly closed, and that its gravity should not be exaggerated.

At all events, we believe that the form which De La Rue has given to the battery does not present this little disadvantage, and that it contains several very interesting dispositions. Figure 46 represents a battery of ten cells, each of which is composed in the following manner:

The outside cylindrical jar is about 5 in. high and 1½ in. in diameter. The soluble electrode is formed of a rod of unamalgamated zinc, but of very good quality. In the upper part of this zinc rod is bored a hole, in which a strip of silver (positive connection of the adjoining cell) is held by means of a small brass wedge, which assures a perfect contact between the zinc and the silver.

The other electrode is formed of a strip of silver around which is melted a cylinder of chloride of silver, AgCl, represented separately in the figure.

To avoid an accidental contact of the two electrodes, the rod of chloride of silver is placed in a small cylinder of

parchment paper, A; there are two holes near the top of this paper cylinder, through which the strip of silver passes, as shown in B.

The liquid is a diluted solution of sal ammoniac; the best proportion is that of 23 grammes of chloride of ammonium to 1 litre of distilled water.

[fol. 758]

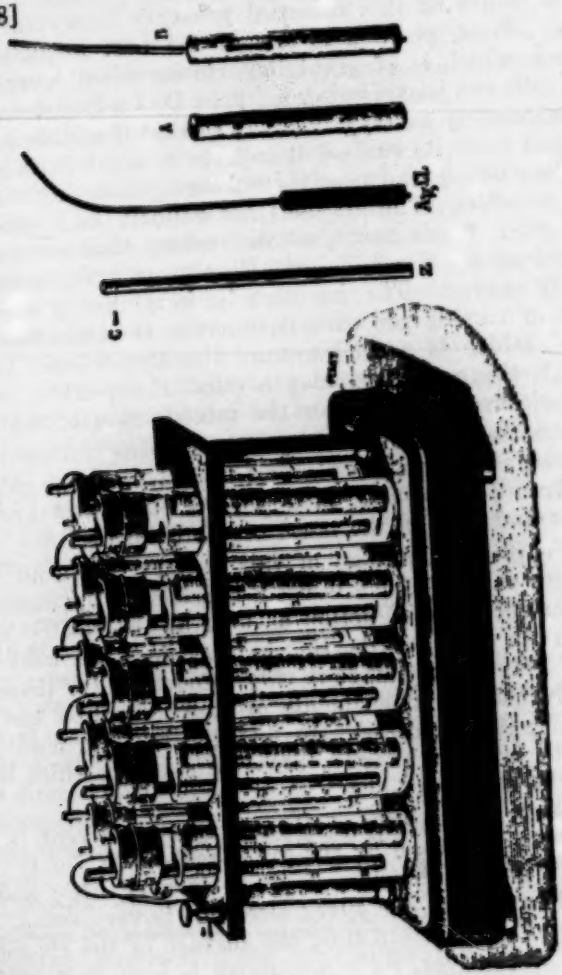


FIG. 46.

[fol. 759] The outside jar is closed with a paraffin stopper through which the zinc passes; the strip of silver passes between the stopper and the glass jar. The figure also shows that there is a hole made in the paraffin stopper, through which the liquid is poured in by means of a small funnel, and then the hole is closed with a small paraffin cork.

The choice of this material presents important advantages. First, paraffin is one of the best insulating substances, which is of great importance when several thousand cells are joined in intensity, as De La Rue does. Then it is absolutely antihygrometric, so that if a little water be dropped upon its surface it collects in many little globules and does not spread over the surface, which might destroy the insulation. The air does not deposit itself upon it as upon glass, for instance, whose surface thus covered with steam becomes a conductor. Finally, paraffin melts when slightly heated. The jar may be hermetically closed by means of a small iron wire, flattened at the end and slightly heated, which is passed around the zinc where it comes through the cork, and also around the paraffin stopper which closes the orifice for the introduction of the liquid.

The action in this battery is very simple: the zinc is dissolved and takes the place of the silver in the chloride; the silver is deposited in a rous mass first upon the surface and then in the mass of the chloride.

The capital advantage of this battery, as in all where zinc with sal ammoniac is used, consists in the absence of any local or internal action as long as the electric circuit is open; in other words, this battery does not work upon itself. This circumstance is very important, for these cells are only used in experiments of short duration and long intervals; it is necessary to find the battery, eight days [fol. 760] later, in exactly the same state in which it was left eight days previous.

In the first moments of the action the current is very feeble; this is caused by the great resistance, for the conductivity of the chloride of silver is very little and the exposed surface of the silver electrode is very small. But at the end of a certain time the surface of the chloride is covered with silver, its conductivity is increased, and the intensity attains its normal value, which varies but little

afterwards, as is shown by the following table of experiments made by De La Rue with a voltameter:

	Gas per Minute.
At the start, June 29th, 1875	1 cent. cube.
July 4th, "	1.4 " "
Oct. 27th, "	1.4 " "
March 15th, 1876	1.45 " "
April 8th, "	1.41 " "

The electro-motive force of these cells differs very little from that of the Daniell. De La Rue found it to be 0.97 with sea salt, and 1.03 with sal ammoniac.

The resistance is about 4.3 ohms, as nearly as could be ascertained.

For the above-mentioned experiments De La Rue collects 200 cells upon a single board; they pass through a slab of ebonite, which is a better insulator than wood.

Six of these batteries of 200 cells each are placed one above the other in a carefully constructed closet which protects them from dust or from accidents.

This is not the place to enlarge upon De La Rue's experiment. We would only say that he has again proved that electricity generated by batteries differs in no way from that generated by electric machines, and that if a sufficient number of cells be joined to form a battery, a [fol. 761] continuous spark is observed when the extremities of the two connections are brought in close proximity to each other. De La Rue has collected as many as 8000 cells in one battery, many more than any one had previously collected, and he proposes soon to make a battery of 12,000 cells.

There can be no polarization in the experiments made by this physicist, as they last but a short time and are made at such long intervals, as is the case in nearly all purely scientific experiments. But Du Moncel has made some direct experiments which prove that after the circuit has been closed twenty hours the battery shows no polarization; and if, in fact, the action takes place as we have said—that is, the simple substitution of zinc for silver in the chloride—there is no hydrogen set free, and consequently no polarization. As the deposit of silver upon the conducting electrode does not change the nature of the latter, the conditions are the same as in the Daniell battery, which is the model of completely depolarized batteries.

Gaiffe's Battery

The chloride-of-silver battery is very extensively used by Gaiffe for induction-coils or to furnish continuous currents used for medicinal purposes.

His cells are very small and hermetically closed in ebonite boxes having screw tops.

In those batteries which are destined to be transported frequently from one place to another there is no free liquid; the two electrodes are separated by six or eight sheets of blotting-paper saturated with a solution containing 5 per cent of chloride of zinc.

[fol. 762] Gaiffe has employed powdered chloride of silver, but he now seems to prefer the melted chloride.

The residue of the battery is silver, and if it be kept and given back to the manufacturer its use is very economical.

Figure 47 represents another cell which stands on end, and in which liquid is placed as in ordinary batteries.

The electrodes are, as is seen, attached to metallic pieces

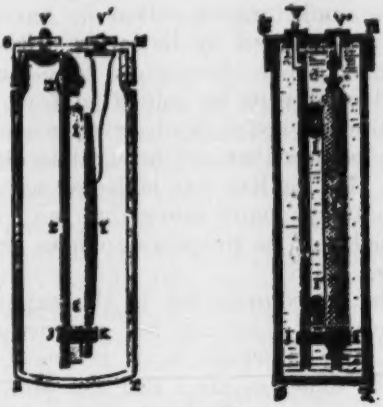


FIG. 47.

which pass through the top, and to which are fastened the connections of the adjoining cells.

There is no waste in these batteries when the circuit is open, which is of great advantage. It is important to note that, in order not to lose this advantage, the top must be kept perfectly dry, for the least humidity that might join

the electrodes would establish a circuit and produce a constant working in the cell.

[fol. 763] Chloride-of-Lead Battery

Marié Davy tried the use of chloride of lead, but the electro-motive force thus obtained was less than the unit (Daniell's cell). There is therefore no advantage in its use, for chloride of lead is comparatively dear.

Perchloride-of-Iron Battery

In 1866 Duchemin proposed the use of perchloride of iron as depolarizing agent. This substance is pointed out as containing a quantity of chlorine, as are the peroxides of lead and of manganese, which contain large quantities of oxygen.

The battery in question has an electrode of zinc immersed in a solution of sea-salt, and an electrode of carbon in a solution of perchloride of iron.

The hydrogen given off by the action of the zinc upon the water goes straight to the carbon and decomposes the iron salt, which is transformed into protochloride.

The hydrochloric acid, formed by the combining of the polarizing hydrogen and the chlorine set free from the perchloride, contributes to the dissolving of the zinc and to the intensity of the battery.

This cell is not constant; first because depolarization is not complete, and again because there are deposits, possessing little conductivity, made upon the zinc.

Du Moncel has shown that the electro-motive force of this battery is, at first starting, very superior to that of Marié Davy's battery, and inferior to that of Bunsen's battery.

[fols. 764-765] The figures are:

Bunsen or Grove cell	11.123
Perchloride of iron	9.640
Marié Davy's sulphate-of-mercury cell	8.192

The contrivance proposed by Duchemin would therefore appear worthy of study. It is probable that, by means of some chemical or physical artifices, the constancy of this battery might be increased.

The mixture of pieces of carbon with the perchloride of iron has already been tried, and with good results.

(Model.)

P. S. HAYES.

CHLORIDE OF SILVER BATTERY.

No. 282,634. Patented Aug. 7, 1883.

Fig. 1.

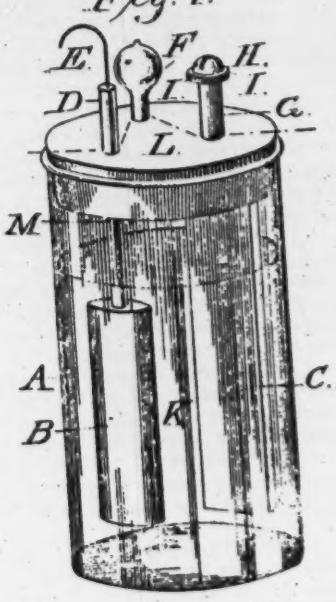


Fig. 2.

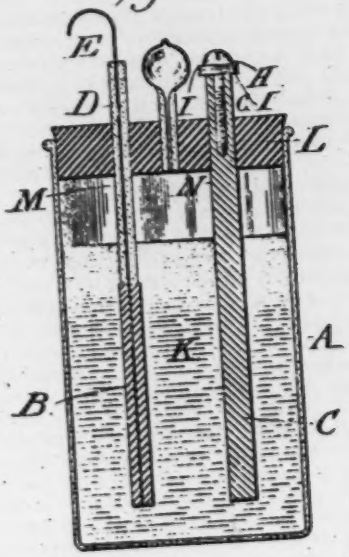


Fig. 3.

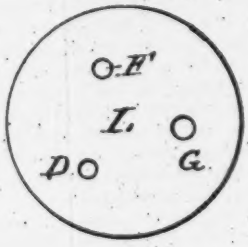
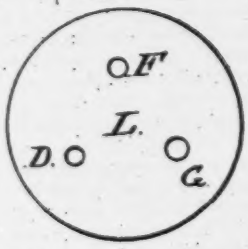


Fig. 4



Witnesses;
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J. le Wildman

Inventor;
Plymmon S. Hayes. M.D.
by T. T. Hayden, Atty.

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UNITED STATES PATENT OFFICE.

PLYMMON S. HAYES, OF CHICAGO, ILLINOIS.

CHLORIDE-OF-SILVER BATTERY.

SPECIFICATION forming part of Letters Patent No. 282,634, dated August 7, 1883.

Application filed October 21, 1882. (Model.)

To all whom it may concern:

Be it known that I, PLYMMON S. HAYES, a citizen of the United States, residing in the city of Chicago, county of Cook, and State of Illinois, have invented a new and useful Improvement in Chloride-of-Silver Batteries; and I do hereby declare that the following specification is a true, clear, and complete description of my invention, and that it will enable others skilled in the art to which it appertains to make and use the same.

The object of my improvement is to prevent the gradual exhaustion of the chloride-of-silver battery, when not in use, through the connection of the poles of the battery by the liquid from the battery adhering to the lower surface of the stopper or conveyed through it by permeation, and to prevent the formation of sulphide of silver on the silver wire which forms the positive pole of the battery, and to make the battery portable. These results I claim to have fully accomplished by my invention, which is illustrated by the accompanying drawings, viz.—

Figure 1 showing a perspective view, and Fig. 2 showing a vertical sectional view, Figs. 3 and 4 showing horizontal or top views.

Similar letters refer to similar parts in each.

My invention consists of the insulating glass tube D, extending from the top of the chloride-of-silver plate B through one of the three perforations in the stopper L and above the same a convenient length for practical use. Through this insulating glass tube a fine silver wire, E, passes and is carefully cemented therein, extending from the top of the chloride-of-silver plate B, which is submerged in the battery-fluid K, through the insulating glass tube D, and above the same a sufficient length for practical use. The insulating glass tube D thoroughly covers the silver wire E, which, from its connection with the chloride-of-silver plate B, forms the positive pole of the battery and prevents the positive and negative poles M and N from connection by action of the battery-fluid K by its adherence to the under side or permeation through the stopper L. The insulating glass tube D also prevents the silver wire E from coming in contact with the stopper L, and prevents it from being acted upon by the sulphur contained therein when a rubber stopper is used. The insulating glass tube D furthermore stiffens or supports the silver wire E and renders the silver-chloride plate B less liable to come in contact with the zinc plate C, by the bending of that part of the silver wire E below the stopper L from the weight of the chloride-of-silver plate B on receiving a sudden jar or from falling on its side, than if the insulating glass tube were wanting.

To carry my invention into effect I take a wide-mouth glass vessel of suitable size (see Fig. 1, A A) and fit into it a rubber cork or other suitable stopper, perforated in three places with holes of proper caliber, forming the points of an equilateral triangle far enough distant from the periphery of the stopper for the purposes intended, which are as follows, viz: Through one of these perforations of the stopper L a capillary glass tube, F, with a small bulb near its upper extremity, is inserted, reaching through and terminating with the under surface of the stopper L, which is to operate as a vent for the escape of gas, if any should be generated in the battery, the opening being too small, however, to allow the battery-fluid to escape or run through it, even if the battery should fall upon its side or be turned upside down, and without which vent the battery-fluid would be forced around the poles of the battery M and N, which pass through the stopper L or between it and the sides of the vessel or cell. Through another of these perforations in the stopper L the negative pole N of the zinc plate C passes. Through the third or remaining perforation the insulating glass tube D, which I particularly claim as my invention or improvement, passes, inclosing the silver wire E, which connects with and passes through the full length of the chloride-of-silver plate B and through the insulating glass tube D a sufficient length for the uses intended, said insulating glass tube D extending below the surface of the battery-fluid K and completely insulating the silver wire E down to the point where it enters and passes through the full length of the chloride-of-silver plate B.

The battery-fluid K consists of about two per cent. of solution of sodium chloride, or the same quantity of ammonium chloride, and ninety-eight per cent. of distilled water.

The zinc plate C is made of rolled zinc of suitable length, breadth, and thickness, the upper end turned down to the proper size to admit its

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passing from the underneath side of the stopper L, and extending a suitable distance above the upper surface of the stopper L, on the apex of which is fitted a screw, H, which passes through the small copper washers I and I, which answers the purpose of a "binding-post" for connecting the wire of the negative pole N.

The chloride-of-silver plate B consists of perfectly pure chloride of silver fused on a wire of pure silver, E, the wire extending through the full length of the plate B, and of sufficient length above the upper end of the plate B to extend through the insulating glass tube D, and of sufficient additional length for practical use.

Where a rubber stopper is used all that part of it remaining above and outside the mouth of the jaw or cell A A should be varnished to prevent the exhalation of sulphur from the rubber.

A chloride-of-silver battery is one of exceedingly constant electro-motive force. It occupies but a comparatively small space. The battery-fluid contains no free acid. The silver chloride furnishes a constant supply of chlorine when the battery is in use, and this supply of chlorine continues until all the silver chloride is converted into pure metallic silver, at which time the battery is exhausted and has to be supplied with a new battery-fluid and a new silver-chloride plate. The life of a battery of this description is of much longer duration than any other now in use.

The form of the battery above described is applicable to any use where a galvanic battery of considerable electro-motive force is required in a small space and in a portable form, and where the work to be done is through a conductor or conductors of high resistance.

What I claim as my invention or improvement in a chloride-of-silver battery, and desire to secure by Letters Patent of the United States, is—

The combination, in a chloride-of-silver battery, of the glass tube D, inclosing the silver wire E, which connects with the silver plate B and the capillary glass tube F, with a small bulb near its upper extremity, substantially as described.

PLYMMON S. HAYES.

Witnesses:
C. H. BRADLEY,
M. K. LISTON.

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[fol. 769] IN THE UNITED STATES COURT OF CLAIMS

DEFENDANT'S EXHIBIT No. 3

GALVANIC BATTERIES

Their Theory, Construction and Use

Comprising

Primary, Single and Double Fluid Cells, Secondary and Gas Batteries

S. R. Bottone

Late of the Collegio del Carmine, Turin; of the Instituto Bellino, Novara; and of the Carshalton School for Cadets

Author of 'The Dynamo,' 'Electrical Instruments,' 'Electro Motors,' 'Radiography,' 'Wireless Telegraphy,' Etc.

With 144 Illustrations

Whittaker & Co.
2, White Hart Street, Paternoster Square, London
New York: 66, Fifth Avenue
1902

[fol. 770] From molecule to molecule, in the chain reaching from the zinc plate to the zinc-oxide incrusted carbon, these interchanges go on; here the free hydrogen seizes on the oxygen of the zinc oxide to form water, which mixes with the solution to undergo again the same cycle of changes, while the liberated zinc is taken up by the freshly-formed hydrochloric acid. But when the circuit it opened, and connection between the zinc and carbon interrupted, all action ceases.

§ 85. To *De La Rue* we are indebted for the application of silver chloride as a depolarizer. In the original form of this cell, a stout silver wire formed the negative element. Around this was cast a cylinder of silver chloride, Ag Cl,[1] and this was placed in a small cell, along with an unamalgamated zinc rod. The excitant employed was a solution of common salt Na Cl. The zinc and salt reacted, giving rise to zinc chloride $Zn Cl_2$ and sodium Na. In the presence of water this latter instantaneously seized upon the oxygen of the water, with the formation of soda, and the liberation of hydrogen. This hydrogen in its turn seized upon the chlorine of the silver chloride, producing metallic silver, and hydrochloric acid, thus $H_2 + 2 Ag Cl = Ag_2 + 2 H Cl$. The silver thus liberated, thickened the original silver wire; the hydrochloric acid produced, combined with the soda first liberated, to form salt and water, thus $2 H Cl + Na_2O = 2 Na Cl + H_2O$. A modification consists in using a glass tube 6″ long by ¾″ diameter inside, closed by a vulcanized [fol. 771] india-rubber stopper, which is pierced in two places—one hole being central, to allow the passage of a flattened silver wire 1/16″ broad and 8″ long, reaching to the bottom of the tube; the other hole more to the side, which admits of a well-amalgamated zinc rod 4½″ long, 3/16″ diameter. To prevent the silver being affected by

[1] The precipitated salt is not so active; it must be *fused* to give good results.

Fig. 70.

the sulphur in the vulcanized rubber stopper, it is wrapped round for about half its upper length with thin sheet gutta-percha (see Fig. 70). In the bottom of the tube are placed 225·23 grains, about half-an-ounce, or 14·59 grammes of powdered silver chloride. This is the depolarizer. Above this is placed a solution of sodium chloride, containing 25 [fol. 772] grammes in 1 litre of water, or 1752 grains in 1 gallon, or a solution of ammonium chloride, containing 23 parts in 1000 parts of water, which is the approved excitant. This liquid is poured in until the level rises to about 1 inch from the stopper. The silver is surrounded by a vegetable parchment tube, through which it passes at the top, to separate it from accidental contact with the zinc rod. Water can be added through a plugged hole in the stopper. Connection of one cell to another is made by passing a short piece of india-rubber tube over the zinc of one cell and drawing the silver wire of the next cell in so as to press against the zinc. E.M.F. about 1·3 volts with silver chloride, or ·908 with silver bromide, or ·758 volt with silver iodide as the depolarizer, or of old form with ordinary salt, ·97 volt. The internal resistance of the modified form, with ammonium chloride, 4·2 ohms. The cell used by De la Rue and Müller in 1868 was suggested by Marié Davy in 1860. A new cell gives a very feeble cur-

rent at first, but after a time the reduced silver of the silver chloride forms a larger silver surface, and the current attains its normal strength. Warren de la Rue and Müller used a battery of 14,400 such cells for their researches on the electric discharge in rarefied gases. A battery of 8040 cells gave a spark ⅓ of an inch long in air at the ordinary pressure, and 1⅛ inch under a pressure of a quarter of an atmosphere. The length of the arc found between the terminals varies with the square of the number of cells in series. Thus, while 1000 cells give a spark of ·0051 inch under ordinary atmospheric pressure, [fol. 773] 11,000 cells give a spark of ·62 inch. The equation representing the action is probably as follows:—

$$2\,NH_4Cl + Zn = ZnCl_2 + 2\,NH_3 + H_2.$$

The liberated ammonia reacts with the zinc chloride:—

$$2\,NH_3 + ZnCl_2 = (NH_3)_2ZnCl_2 + H_2.$$

The equation representing depolarization:—

$$4\,H + 4\,AgCl = 4\,HCl + 4\,Ag.$$

Sometimes the tubes are stopped with paraffin instead of vulcanized rubber. *Pincus* constructed a battery for medical purposes, using silver chloride independently of De la Rue.

§ 86. *Gaiffe's Cell.* Constituents:—Zinc and silver chloride, in zinc chloride. Arrangement:—Outer cell made of ebonite to which a lid is screwed. The two electrodes are fixed to the lid. The negative electrode, consisting of a cylinder of fused silver chloride, is placed in a copper vessel covered with linen. The electrodes are kept in position by india-rubber rings and pieces of caout-chouc. The cell must not be upset, as by wetting the lid the cell becomes short-circuited. Gaiffe prevented this by putting several layers of filter paper, wetted with a solution of zinc chloride, between the electrodes instead of the liquid. E.M.F. 1·02 volts.

Remarks:—Intended for medical purposes, also used as a standard cell with condensers and electrometers. The cylinder of silver chloride may have a silver wire imbedded in it.

§ 87. *Skrivanow's Cell.* Constituents:—Zinc and chloride [fol. 774] of silver in a solution of caustic potash. Arrangement:—The cell is similar to De la Rue's, the silver chloride being in a parchment paper receptacle. The ex-

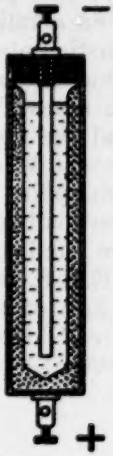

Fig. 71.

citing solution is 75 parts of potassium hydroxide in 100 parts of water. E.M.F. = 1·45 to 1·5 volts. A cell weighing 100 grammes can give out 1 ampère for 1 hour. After that amount of work, the potash must be renewed, and also after two or three changes of potash the silver chloride needs replacing.

§ 88. *J. Mackenzie,* in 1882, patented a modification of the De la Rue cell. With the intention of rendering the cell less liable to fracture, and therefore portable as a [fol. 775] pocket cell, he constructed the outer case in the form of a copper tube, fitted with a copper plug at the bottom. This was heavily silvered in the inside. The interior was then coated with a layer of fused silver chloride. A stopper of ebonite, or other suitable insulator, impermeable by moisture, was made to screw into the top of the tube at the open end, and through this stopper passes a zinc rod or cylinder, having a screw thread cut at its upper extremity, so as to make a watertight fit. This rod of zinc reaches nearly to the bottom of the copper cylinder. The exciting fluid consists of an aqueous solution of either zinc

chloride, zinc sulphate, or sodium chloride, preferably the former. Fig. 71 is a sectional view of the Mackenzie cell.

§ 89. Hitherto we have considered cells in which the excitant has been either a dilute acid (a hydrogen salt), or else a saline solution. We now pass to study certain cells in which the excitant is an alkaline solution, such as, for instance, a solution of caustic potash, caustic soda, or caustic ammonia in water. One advantage in such excitants is, that practically no action takes place between the zinc (or other positive metal) and the excitant, unless the circuit be closed. Hence little or no waste of zinc occurs on the open circuit. Another good point about them is, that being very good conductors, there is but little internal resistance in cells in which they are employed. The chief drawback lies in the fact that the E.M.F. is small (rarely exceeding 0·8 volt per cell). The first of this class to demand our attention is the *Lalande* cell (1882). The constituents of this cell, as originally devised by Lalande,

* * * * * * *

[fol. 776] IN THE UNITED STATES COURT OF CLAIMS

DEFENDANT'S EXHIBIT No. 4

PRIMARY BATTERIES

By

Henry S. Carhart, A.M.

Professor of Physics in the University of Michigan

Sixty-seven Illustrations
Boston
Allyn and Bacon
1891

[fol. 777] the escape of accumulated gas. The small zinc surface, *V*, means relatively large internal resistance. The plates are made by mixing copper oxide with from 5 to 10 per cent of magnesium chloride, and heating the thick mass in an iron mould.

Fig. 24. — Battery with Compressed Plates of CuO.

43. The Chloride of Silver Cell.—Marié Davy appears to have been the first to suggest the use of silver chloride as a depolarizer about 1860; but it was brought into prominence by the investigations of Warren de la Rue, who constructed a battery of this kind containing 15,000 cells.

The elements are zinc and silver, and on the silver is cast the silver chloride, which is readily reduced to metallic silver by nascent hydrogen. The chloride of silver is easily melted in a porcelain crucible, and may be cast on a silver wire in a hard carbon mould. Silver foil has sometimes been cast in the chloride to give better conductivity. The exciting fluid of De la Rue's battery is ammonium chloride, and contains 23 gms. to one litre of distilled water. A denser solution dissolves silver chloride. The silver and its chloride are surrounded with a small cylinder of vegetable parchment paper (Fig. 25), to prevent short circuits internally, and the zinc rod and silver wire are held in a paraffin stopper. The silver wire of one cell is wedged into the zinc rod of the next.

[fol. 778] The following chemical action takes place:—

$$\overbrace{Zn_x \mid 2NH_4Cl}^{} \mid \overbrace{2NH_4Cl \mid 2AgCl}^{} \mid Ag_y =$$

$$Zn_{x-1} \mid ZnCl_2 \mid 2NH_4Cl \mid 2NH_4Cl \mid Ag_{y+2}$$

This may be considered the normal action; but where the cell is worked hard, it may happen that the ammonic chloride loses chlorine faster than it recovers it from the silver chloride; and the ammonium breaks up into ammonia and hydrogen. The ammonic hydrate thus formed is

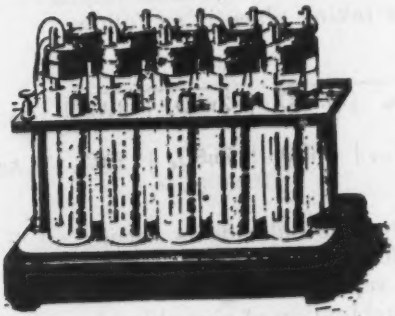

Fig. 23.—Silver Chloride Battery.

capable of dissolving silver chloride, with the formation of ammonio-silver chloride. The hydrogen may reduce silver chloride with production of hydrochloric acid. This acid increases local action. Under such conditions gas may be liberated in the cell, and provision must be made for its escape; or the cell must be made very strong and must be securely sealed.

The initial E.M.F. of a silver chloride cell is about 1.1 volts. Its internal resistance falls very rapidly upon first [fol. 779] closing the circuit, on account of the reduced silver. It polarizes but slightly, and recovers promptly. It is employed chiefly for testing purposes; sometimes for physicians' use. But it should never be put into service requiring anything more than small currents. Upon standing, the zinc is liable to become coated with a thin, adherent

film of the oxychloride of zinc, offering high electrical resistance.

44. Modifications of the Silver Chloride Cell.—The modifications thus far introduced consist in the substitution of some other exciting liquid for the ammonic chloride. Thus caustic potash or soda has been used by Scrivanoff. The chemical reaction is then the same as with the copper oxide cell, except that the hydrogen displaced by zinc unites with the chlorine of the depolarizer, forming hydrochloric acid. A secondary reaction is thus possible, due to the action of the acid on the zinc. There is then greater liability of local action than if the cell were set up with sal-ammoniac.

The excitant may also be zinc sulphate. The displacement process taking place is as follows:—

$$\overbrace{Zn_n \mid ZnSO_4}^{} \mid \overbrace{ZnSO_4 \mid 2AgCl}^{} \mid Ag_y =$$

$$Zn_{n-1} \mid ZnSO_4 \mid ZnSO_4 \mid ZnCl_2 \mid Ag_{y+2}$$

In this case zinc chloride is formed at the expense of silver chloride, and the energy appearing in an electrical form may be represented as due to the difference between the heat of combination of zinc chloride and silver chloride.

The initial E.M.F. with caustic potash is 1.64 volts; with zinc sulphate, 1.16 volts; and with zinc chloride (Gaiffe), 1.01 volts.

[fol. 780] It should be remarked that silver chloride is soluble to some extent in the chlorides of the heavy metallic elements. When the liquid contents of the cell contain as much as one part of concentrated zinc chloride in ten parts of water, the silver chloride is dissolved in quantities which are quite appreciable. Local action then ensues, due to the displacement of silver by zinc, and the zinc rod or plate quickly blackens.

The marked efficiency of silver chloride as a depolarizer is perhaps due to its slow or partial dissolving in the exciting liquid, since liquid depolarizers are, in general, more effective than solid ones. A weak solution of ammonic chloride may not attack the solid silver chloride. Hence local action does not take place so long as these cells have

not been placed in use; but immediately upon closing the circuit through them zinc chloride is formed, and thereafter local action begins to exhaust the silver chloride with blackening of zinc. So that silver chloride cells that have been much used will not stand on open circuit without waste. Morever, their internal resistance will increase if the zinc becomes encased in the film of oxychloride before mentioned.

(No Model.)

J. A. BARRETT.

GALVANIC BATTERY.

No. 405,196. Patented June 11, 1889.

Fig. 1.

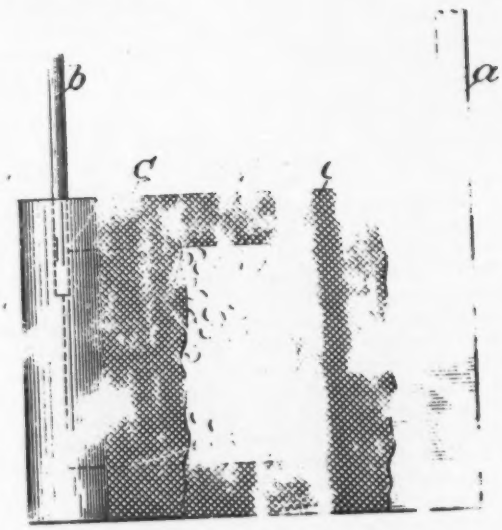

Fig. 2.

Fig. 3

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WITNESSES:

J. A. Hurdle

S. Field.

J. A. Barrett

INVENTOR

BY McGipher Worthington & Co.

ATTORNEYS.

53

UNITED STATES PATENT OFFICE.

JOHN A. BARRETT, OF BROOKLYN, NEW YORK, ASSIGNOR TO THE JOHN A. BARRETT BATTERY COMPANY, OF BALTIMORE, MARYLAND.

GALVANIC BATTERY.

SPECIFICATION forming part of Letters Patent No. 405,196, dated June 11, 1889.

Application filed April 5, 1889. Serial No. 306,109. (No model.)

To all whom it may concern:

Be it known that I, JOHN A. BARRETT, a citizen of the United States, residing at Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Galvanic Batteries; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to certain improvements in galvanic batteries, the objects of which improvements are, among other things, to simplify the construction and increase the life of the battery and its efficiency.

My invention, so far as concerns the solution claimed, has special reference to chloride-of-silver batteries; and its object is to avoid the undue wasting of the silver element of plate and the undue formation of troublesome double salts or foreign and insoluble compounds that tend to clog the action of the battery.

The object of the invention is, further, to avoid the deposition of silver upon the zinc or positive plate of the battery.

A further object of my invention is to provide a silver plate or element in which the chloride of silver shall be better applied to give a more economical and efficient action.

The object of my invention is also to apply or combine the active salt or battery material with the battery elements or plates in a convenient manner and in such way that the battery may be rendered active by simply dipping the battery elements into water, and that the operative part of the battery may be put up in compact form, and may be readily transported before use without liability to loss or displacement of the charging material.

In chloride-of-silver batteries of the ordinary kind the practice is to employ a solution of sal-ammoniac, chloride of sodium, chloride of zinc, &c., as the liquids in which the zinc and silver elements of the battery are immersed. The objection to solutions of these and of other kinds heretofore employed in batteries of this kind is, that the chloride of silver is soluble in them unless the solution is made very weak, and the silver is liable to deposit on the zinc element, while if the solution is made weak the current is cut down, owing to the increased internal resistance. These solutions are also objectionable, in that they produce insoluble compounds that interfere with the free action of the battery.

My invention consists in the employment for a chloride-of-silver battery of a solution of sulphate of zinc, and in the construction and arrangement of the elements, as hereinafter fully described and claimed.

I employ sulphate of zinc in solution, as I find that with this solution the formation of the troublesome double salts is avoided and the dissolution of the chloride of silver is prevented. I find, also, that although in my improved solution the chloride of silver will not dissolve to any troublesome extent, yet the battery is strong and constant, as well as free from the objections before mentioned.

In the ordinary forms of chloride-of-silver battery the chloride of silver is attached to the silver plate or element in a solid mass, the chloride being for this purpose fused about the silver element in a mold. This manner of applying the chloride of silver is wasteful, and the solid mass of chloride interferes with the free action of the battery. I apply the chloride in a thin layer or film over the surface of the silver, and to aid in the application of the chloride in this way I prefer to employ as the silver element a thin sheet of silver, upon which the chloride of silver is spread, and is then fused by simply passing the sheet of metal over a flame. If applied in small enough quantity, the effect is to cause the fused chloride to adhere to the plate in small blotches or spots thickly disposed over the silver surface and leaving the silver exposed in places. A silver plate or element thus prepared I find to be very efficient, while requiring a minimum amount of chloride in order to produce the desired effect in the battery.

The silver plate I make so thin that it may readily be rolled into a spiral, as will be presently described.

I prefer to charge the battery with the sulphate in a dry form, and for this purpose I impregnate the porous diaphragm between the zinc and silver elements with the salt by boil-

ing or saturating the diaphragm with a saturated solution of the salt, after which the liquid is evaporated, leaving the salt in a dry or inactive state. The porous diaphragm may then be in contact with both elements without producing action, while the addition of water will at any time put the battery into an active condition.

The porous diaphragm I prefer to make of a textile fabric—such as cotton cloth—and to interpose the same between and in contact with the zinc and silver elements. If the latter (the elements) be made so thin as to be flexible, they may be rolled into a solid spiral with layers of the impregnated fabric.

In the accompanying drawings I have shown the parts of a chloride-of-silver battery made in accordance with my invention.

Figure 1 is an edge view of the zinc and silver elements and their interposed textile diaphragm partially unrolled from the spiral or volute into which they are formed. Fig. 2 is a side view of the same parts. Fig. 3 is a side view of a portion of the silver element.

A indicates a sheet of zinc sufficiently thin and flexible to be readily rolled up with the thin sheet of silver forming the silver element B. The zinc is provided with an elongated connecting-piece *a*, to which electrical connection may be made, and the silver element has soldered to it a silver wire *b* for a similar purpose. The sheet-silver is supposed to be coated with its film of chloride of silver. Two pieces of cotton cloth C C form the porous diaphragm which separates the zinc and silver plate when rolled up into a close spiral. The pieces C C are preferably of sufficient length and width to overlap the edges of the silver plate or element.

The sheets of silver, zinc, and impregnated cloth are rolled together into close convolutions to form a compact mass, readily transportable, and capable of being put into action at any time by simply dipping into water.

What I claim as my invention is—

1. In a chloride-of-silver battery, substantially such as described, a solution of sulphate of zinc.

2. The electric battery comprising a containing-vessel, electrodes, respectively, of chloride of silver and metallic zinc, and a solution of zinc sulphate.

3. In a chloride-of-silver battery, zinc and silver elements formed in thin sheets rolled in a close spiral with interposed sheets of textile fabric impregnated with sulphate of zinc in a dry state.

In testimony whereof I affix my signature in presence of two witnesses.

JOHN A. BARRETT.

Witnesses:
GEO. L. BETTS, Jr.,
GEORGE E. COMYNS.

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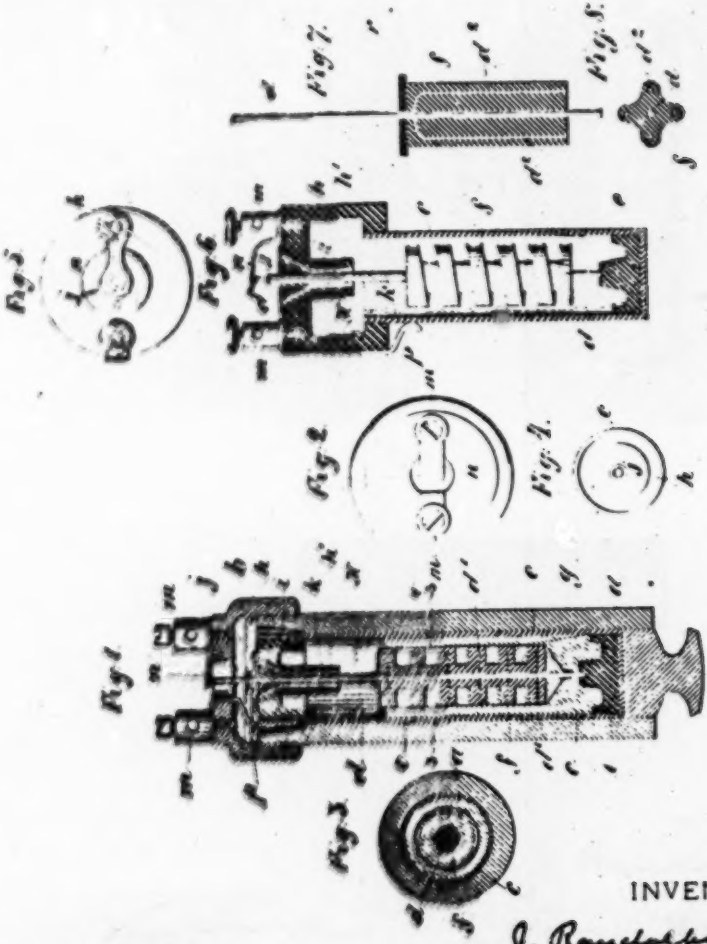
(No Model.) 2 Sheets—Sheet 1

J. R. HARD.

GALVANIC BATTERY.

No. 457,116. Patented Aug. 4, 1891.



534

INVENTOR:

J. Randolph Hard

by Henry Connett

Attorney.

WITNESSES:

Chas. A. Goldsborough

Chas. A. Goldsborough

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(No Model.) 2 Sheets—Sheet 2.

J. R. HARD.

GALVANIC BATTERY.

No. 457,116. Patented Aug. 4, 1891.

Fig. 10.

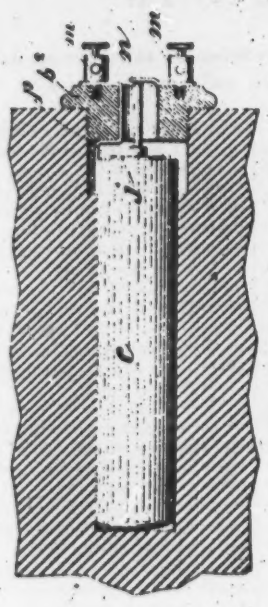


Fig. 11.

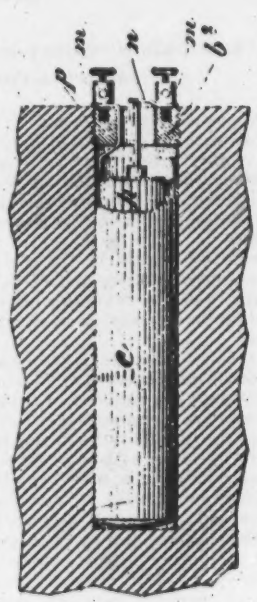
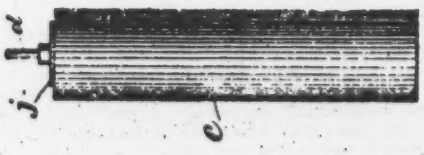


Fig. 9.



535

INVENTOR:
J. Randolph Hard
By Henry Connett
Attorney.

WITNESSES:
H. Caplinger
Chas. A. Walsh

535

UNITED STATES PATENT OFFICE.

JOHN RANDOLPH HARD, OF NEW YORK, N. Y.

GALVANIC BATTERY.

SPECIFICATION forming part of Letters Patent No. 457,116, dated August 4, 1891.

Application filed February 6, 1891. Serial No. 380,440. (No model.)

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To all whom it may concern:

Be it known that I, JOHN RANDOLPH HARD, a citizen of the United States, and a resident of the city, county, and State of New York, have invented certain Improvements in Galvanic Batteries, of which the following is a specification.

My invention relates in the main to the class of open-circuit dry batteries, and the novel features of the invention will be fully set forth hereinafter, and carefully defined in the claims.

In the present instance I have shown my improvements embodied in a cell wherein the positive element is a zinc cup of tubular form and the negative element is a rod or piece of chloride of silver, this latter being immersed in an excitant mixed with some mucilaginous or gelatinous substance, which renders it too stiff or immobile to flow. The zinc cup constitutes one pole of the cell, and a wire of silver, embedded at one end in the negative element and projecting outward through a closing plug or stopper in the cup, constitutes the other pole of the cell. In cells of this general class it has been found that when the battery is in action gases are generated and some liquid also is formed, which rises to the surface of the excitant compound, and the interial pressure therefrom often bursts the inclosing casing. Where a stopper of porous material has been employed to close the zinc cup, the pores thereof, which are of a capillary nature, are liable to become clogged with the viscid liquid, and thus cut off the escape of the gases, and this is inevitable where the cell is inverted or even permitted to rest on its side. My object is, in part, to correct these defects by providing a gas outlet or outlets and means whereby the liquid is prevented from closing said outlets should the cell be inverted or turned on its side. Another object is to provide the gas-outlet of the cell with a valve to prevent the access of air to the exciting compound, as will be described. Other features of novelty will be set forth hereinafter.

In the drawings which serve to illustrate an embodiment of my invention, Figure 1 is a longitudinal axial section of battery-cell embodying my invention set in a casing. Fig. 2 is an end view or plan view of the same. Fig. 3 is a transverse section of same, taken on line 3 3 in Fig. 1; and Fig. 4 is an end view of the cell detached. Fig. 5 is an end view, and Fig. 6 a longitudinal axial section, of a slightly-different form of battery-cell embodying my invention. Figs. 7 and 8 are respectively longitudinal and transverse sections of a modified form of the chloride-of-silver element of the cell. Fig. 9 is a side elevation of the cell detached from the casing. Figs. 10 and 11 are views illustrating a mode of mounting the battery-cell in a casing formed by boring a hole in a timber or any structure of wood.

Referring, primarily, to the first four figures of the drawings, which illustrate the essential features of the cell, *a* represents an outer casing, which may be of wood, hard rubber, or the like, and *b* is the cap of the same, which may be of the same material. The cap is here shown as arranged to screw onto the open end of the casing *a*.

c is the zinc cup forming the positive element of the galvanic cell. As here shown, this cup is of an elongated cylindrical form.

d is a metal rod or wire of silver, which rests at its lower end on an insulating washer or piece *e* in the bottom of the cup *c*. On the rod *d* is the negative or chloride-of-silver element *f* of the cell. By preference this element will be of substantially cylindrical form, with circumferential grooves formed in it, as clearly shown in Fig. 1. Surrounding the element *f* is the excitant compound *g*. This compound will be stiff or jelly-like, and it will enter into the lateral grooves or recesses in the element *f*. The open end of the zinc cup is closed by a stopper *h*, which will be by preference of wood, hard rubber, or the like.

The rod *d* passes out through an aperture in the stopper *h*, and in the latter is formed one or more gas-outlets *i*, which may be closed by a self-closing valve *j*, mounted on the stopper. This valve may be in the form of a rubber disk, secured to the stopper or to a rubber protecting-covering *k* on the rod *d*. The valve *j* seals the chamber containing the exciting compound and prevents the access of air thereto. If the air has access to this compound, it will have the effect of drying it by removing its moisture, and thus to a degree render the excitant inert. The valve also

keeps out dust and foreign substances which might clog or stop up the gas-outlet, and thus interfere with the proper operation of the cell.

On the cap *b* are mounted the binding-posts *m*, to which the circuit-wires are secured. Connected electrically with the respective binding-posts are metallic contacts *p* and *n*, the former being so placed as to form a rubbing contact with the outer face of the zinc cup *c* when the cap *b* is screwed on, and the latter being arranged to bear elastically on the projecting tip of the rod *d* under the same conditions. The casing *a* is enlarged or cut away at its open end in order to make room for the contact *p*.

I will now explain more fully some of the details of the construction and explain the purpose thereof. The insulating-piece *e* is recessed in its upper face in order to increase the distance between the rod *d* and the wall of the cup *c*, measured over the surface of said piece *e*. I believe the insulation is better under these conditions than it would be if this surface were a plane. In order to increase the surface of contact between the chloride-of-silver electrode *f* and the rod *d*, I prefer to secure on the rod *d*, primarily, disks of silver *d'* at proper intervals, and when the chloride is melted and molded about said rod these disks will be embedded in the chloride, as seen in Fig. 1. I find, also, that it improves the action of the cell to wrap the chloride-of-silver electrode wholly or in part in a cloth or fibrous fabric coated with plumbago or finely-divided carbon, the ends of said fabric being secured to the rod *d*. This fabric *o* is seen in Fig. 1. The fibrous and absorbent nature of this wrapping permits the excitant compound to pass through it with sufficient freedom, and the conductive coating of the fabric sets up a galvanic action quickly when the circuit is closed. As before stated, when these cells are in action a liquid collects above the excitant, and as the cell will sometimes require to be placed on its side, or even be inverted, this liquid will naturally collect about the plug *h*. To obviate the difficulties growing out of this, I leave a considerable space *x* between the element *f* and the stopper *h*, or within the stopper, to receive this liquid, and I form a centrally-arranged nipple *h'* on the stopper *h*, within which is the gas-outlet. Thus whatever position the cell may occupy—erect, on its side, or inverted—the accumulation of liquid will not reach and obstruct the gas-outlet. The excitant compound will be quite stiff or immobile, and its engagement with the lateral recesses in the chloride-of-silver electrode will tend to prevent the displacement of said compound.

Should gas be generated in the cell, it can never reach such a tension as would burst or injure the cell, as the valve will rise and permit it to escape under a moderately-low tension.

Figs. 5 and 6 illustrate a slightly-different construction, wherein the stopper that closes the zinc cup is arranged to fit over the open end of the cup. In this form of the cell the binding-posts and contacts are mounted directly on the stopper. In this view the chloride-of-silver element is seen in elevation, and it is in the form of a screw. The exciting compound is not shown in Fig. 6.

Figs. 7 and 8 show a form of the chloride-of-silver element which has silver wires *d'* extending through it longitudinally, the element being fluted.

Figs. 10 and 11 show the battery-cell set in a hole bored in wood, which may represent the frame or casing about a door. In Fig. 10 the hole is counterbored, and a plug h^3, corresponding in function to the cap *h* of Fig. 1, is screwed into the larger part of the bore. In Fig. 11 the general construction is the same as that in Fig. 10, except that the hole is not counterbored to receive the plug, which latter has substantially the same diameter as the cell. In this construction the stopper *h* of the cell is set back or in a little way, and the contact *p* enters the zinc cup and bears against its inner face exterior to the stopper. The zinc cup is broken away in this view to show the special construction.

If the chloride of silver element *f* be not provided with lateral grooves for preventing the movement or shifting of the exciting compound, or if said compound be somewhat too liquid, a washer of porous material may be placed in the cup *c* over the element *f*. Such a washer *r* is seen in Fig. 7.

The coating of carbon on the strip *o* may be placed on the inner face of said strip, so as to form a coating on the element *f*, and one mode of carrying out this feature of the invention would be to apply a coating of the conducting material to the surface of the chloride of silver and then cover it with a thin absorbent fabric.

The conical enlargement of the casing *a*, as seen in Fig. 1, serves to force the spring contact-piece *p* inwardly against the zinc cup *c* as the cap *b* is screwed down on the casing and to cause the said piece to rub frictionally over the surface of the zinc and effect a good contact.

Having thus described my invention, I claim—

1. A closed galvanic cell having a gas-outlet in its closing-stopper, and a self-closing valve controlling said outlet, said valve opening outwardly, substantially as set forth.

2. A galvanic cell having a closing-stopper provided with a centrally-arranged inwardly-projecting nipple, and with a gas-outlet extending through said nipple and stopper, substantially as set forth.

3. A galvanic cell having a closing-stopper provided with a centrally-arranged inwardly-projecting nipple, with a gas-outlet extending through said nipple and stopper, and a self-closing valve which opens outwardly and controls the gas-outlet, substantially as set forth.

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DEFENDANT'S EXHIBIT No. 7

4. A galvanic cell comprising a zinc cup forming one element, a circumferentially-recessed piece of chloride of silver arranged within said cup and forming the other element, a stopper which closes the zinc cup, a rod of silver connected with the chloride and extending out through said stopper, and an excitant compound in which said chloride element is immersed, the said excitant occupying the recesses in the chloride, substantially as set forth.

5. The combination, with a galvanic cell having a zinc cup *c*, which forms the positive element, and a rod *d*, forming the negative element, of a cap adapted to screw onto the zinc cup or its casing, and contact-pieces *p* and *n*, carried by said cap and adapted to be put into contact, respectively, with the cup *c* and rod *d* when the cap is in place.

6. In a galvanic cell, the negative element comprising a circumferentially-grooved piece of chloride of silver *f*, a rod *d*, of silver, extending into said chloride, and disks or plates *d'*, of silver, attached to said rod and embedded in the chloride, substantially as set forth.

7. In a galvanic cell wherein the negative element is chloride of silver, the combination, with said chloride of silver, of a conductive coating of carbon applied to the surface of said chloride element, substantially as set forth.

8. In a galvanic cell wherein the negative element is of chloride of silver, the combination, with said chloride element and the silver rod *d*, of a strip of fibrous material *a*, coated with carbon and applied to said chloride element and rod, substantially as and for the purposes set forth.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

J. RANDOLPH HARD.

Witnesses:
HENRY CONNETT,
JOHN D. CAPLINGER.

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DEFENDANT'S EXHIBIT No. 7

(No Model.)

P. HATHAWAY.

GALVANIC BATTERY.

No. 454,598. Patented June 23, 1891.

Fig. 1.

Fig. 3.

Fig. 2.

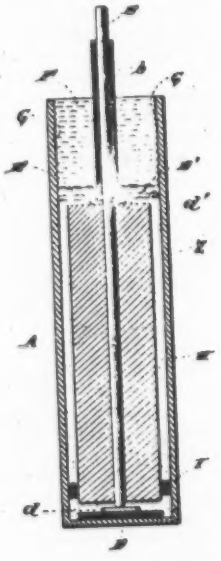


Fig. 4.

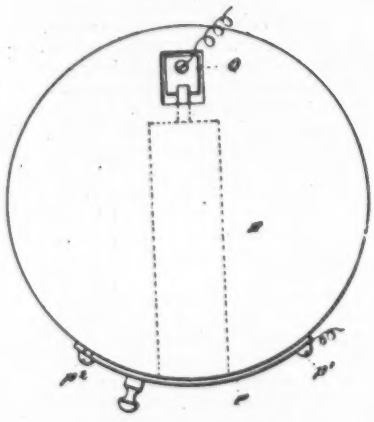
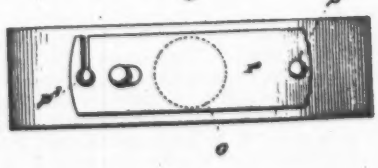


Fig. 6.

Fig. 5.



Witnesses:
H. C. Dewey
Chas. H. Babbitt

Inventor:
Philip Hathaway.

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UNITED STATES PATENT OFFICE.

PHILIP HATHAWAY, OF NEW YORK, N. Y.

GALVANIC BATTERY.

SPECIFICATION forming part of Letters Patent No. 454,598, dated June 23, 1891.

Application filed September 18, 1890. Serial No. 365,445. (No model.)

To all whom it may concern:

Be it known that I, PHILIP HATHAWAY, a citizen of the United States, and a resident of the city, county, and State of New York, have invented certain new and useful Improvements in Galvanic Batteries, of which the following is a specification.

In constructing my improved battery I use zinc for the positive element and chloride of silver for the negative element. I construct the zinc element in the form of a tube closed at one end and open at the other. This tube may be of any required size, but preferentially and for ordinary purposes—such as for use with an electric bell—I make it about two and one-half inches long and about five-eighths of an inch inside diameter. In the upper or open end of the inside of such tube I form circumferential grooves for the purposes of engaging with the cement which forms the seal of the battery, and so rendering such seal more secure. The negative element of the battery is composed of chloride of silver cast in the form of a rod having a deeply indented or corrugated surface for the purpose of exposing the largest possible surface of chloride of silver to the action of the excitant, and also for the purpose of bringing the projecting parts of the surface of such rod as near as possible to the internal surface of the zinc tube, by which means I very largely diminish the internal resistance of the battery, while at the same time, in consequence of the deep recesses formed in the surface of the rod, ample space is obtained for a proper amount of excitant. I form this chloride-of-silver rod by casting the chloride of silver in a mold round a central axis of silver wire or copper wire electroplated with silver, which wire acts as the conductor or electrode of the negative element. This central wire or axis is made longer than the zinc tube, so that when placed therein the upper end of the wire projects and forms a suitable electrode for such negative element. In casting this rod I take especial care that this silver wire shall project from the lower end of the chloride of silver, so as to form a conducting-pole for the electrical current. Such projection should be at least one-eighth of an inch.

In constructing the battery I proceed as follows: I take the zinc tube and place at the bottom of it a washer of the same diameter as the inside of the tube made of hard rubber, glass, or other suitable insulating material, having first affixed to the upper surface of such washer a disk of silver foil of such a size as to extend to a distance of about one-sixteenth of an inch from the circumference of such washer. I then place in the tube any suitable fluid excitant thickened with any suitable thickening material, using, preferentially, an albuminous or gelatinous material for this purpose till such excitant is in a semi-fluid condition or about the consistency of thin jelly. The quantity of such excitant is regulated so as to reach exactly to the top of the chloride of silver when inserted therein. I then slip over the lower end of the chloride-of-silver rod a small rubber ring to prevent the possibility of contact between the rod of chloride of silver and the zinc, and to insure such rod remaining in the center of the zinc tube, the thickness of this rubber ring being such as to fit closely between the rod and the zinc tube, and I incase the upper projecting part of the central wire or axis of such rod with tight-fitting rubber tubing to within a short distance of its upper end. In some cases I place over such rubber tubing a second piece of rubber tubing of such size as to fit closely around the first rubber. I then plunge the chloride-of-silver rod into the zinc tube containing the excitant, so that the projecting lower pole of the central wire or axis of the rod shall rest on the center of the silver-foil disk affixed to the washer placed at the lower end of the tube, and make electrical contact with such disk. I then take another washer made of hard rubber or other suitable non-conducting material, of the exact internal diameter of the zinc tube and having affixed a silver-foil disk of similar size, as before, to the under side of such washer, I make a small hole in the center of such washer and slip it over the rubber-covered wire with the silver-foil disk downward, in such manner as that the silver-foil disk shall rest on the top of the chloride of silver and be in electrical contact therewith. This upper washer will then fit snugly against the inner circumference of the zinc tube, and the upper end of the central wire or axis will project through the center of

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such washer. I then drop a small quantity of melted paraffine on the washer, so as to form a film or thin layer over its upper surface for the purpose of preventing any contact between the excitant and the cement seal next described, and I finally fill the remainder of the zinc tube with Portland cement or with such other similar cement as when set hard will permit the hydrogen gas evolved in the working of the battery to pass through it, but will be completely impervious to the passage of liquids. When such cement is set or dried into a hard mass, the battery is complete. It will be found that a battery thus constructed will possess the least possible internal resistance, will be perfectly dry, and will not be liable to burst, as is very frequently the case with close-sealed chloride-of-silver batteries—as, for instance, in batteries when the seal is composed of plaster-of-paris or other substances practically impervious to hydrogen gas.

In my battery the hydrogen gas escapes freely, partly through the pores of the Portland cement and partly by compressing the rubber tubing placed round the upper part of the central wire, as such tube acts as an elastic vent for the gas, while at the same time the liquid or semi-liquid excitant is effectually prevented either from escaping or evaporating. The escape of the gas can be facilitated by using two pieces of rubber tubing, as before described.

The manner in which I carry out my invention will be readily understood by reference to the annexed drawings, in which—

Figure 1 is a plan of the chloride-of-silver rod. Fig. 2 is a longitudinal section of the battery complete. Fig. 3 shows various forms in which the chloride of silver may be cast so as to form deep indentations, recesses, or corrugations on its surface, for the purposes specified. Figs. 4, 5, and 6 show my methods of connecting the battery with the line-wires of an electrical circuit.

In each figure similar letters indicate similar parts.

In Figs. 1, 2, and 3, A is the chloride of silver; B, the central wire or axis; *b*, the rubber tubing placed over the upper portion of the central wire B, and I the small rubber ring placed over the lower end of the chloride-of-silver rod. Z is the zinc tube or receiving-vessel; D D′, the lower and upper washers having silver-foil disks *d d′* attached or affixed thereto; E, a thin layer or film of paraffine on the upper side of the upper washer D′; F, the cement seal superimposed on the upper washer D′; and G G′, grooves cut in the upper portion of the inner circumference of the zinc tube Z, for the purpose of securely holding the cement seal, and H is the excitant.

In Figs. 4 and 5, O is a cylindrical slot or chamber formed in any suitable part of the apparatus intended to be actuated by the battery. P is a rigid metallic base closing the lower end of the chamber O, and in permanent connection with one of the line-wires of an electrical circuit. Q is a metallic spring in permanent connection with the other line-wire of an electrical circuit, and R is the battery, held firmly by the pressure of the spring Q between such spring and the base P, in such a manner as that the zinc electrode is in electrical contact with P and the silver electrode is in electrical contact with Q. The base P is pivoted at one end, as at p', so as to admit of the ready insertion and withdrawal of the battery, and is furnished with a catch or fastening at the other end, as at p^2. In this method of connecting my battery the circuit is completed or broken by an ordinary circuit-closer placed at any point of the circuit.

In Fig. 6 the battery R is shown placed in the cylindrical slot or chamber O, loosely between the two spring-contact points S and T, so as to be normally out of electrical contact with the other elements forming the electrical circuits. In this method of connection the circuit is closed by the impact of a push-button against one of such contact-springs, thereby pushing the battery forward until each electrode comes into electrical contact with one of the contact-springs S and T. In this case one of such springs is made movable, as S, so as to permit of the ready insertion of the battery in the chamber O and of its withdrawal therefrom. When desired, a wire can be permanently attached to any part of the zinc tube Z, and the battery can be connected by wires in the ordinary way.

I do not confine myself to the precise details herein described, and shown in the annexed drawings, as many variations or modifications may be made therein without in any way departing from the principles of my invention.

What I claim is—

1. In a chloride-of-silver battery, the combination of a zinc vessel containing the negative element and the exciting medium, and also forming the positive element, with a negative element composed of chloride of silver cast in the form of a rod having an indented or corrugated surface, as and for the purposes described.

2. In a chloride-of-silver battery, the combination of the chloride-of-silver rod A with the washers D D′ and the silver disks *d d′*, for the purposes specified.

3. In a chloride-of-silver battery, the combination of the chloride-of-silver rod A with the rubber tubing *b*, placed over the upper portion of the central wire B, as and for the purposes specified.

4. In a galvanic battery, the use of a seal formed of Portland cement or other similar cement pervious to hydrogen gas, but impervious to water or other liquid, superimposed upon a non-conducting washer, as described, for the purpose of confining the excitant.

5. In a galvanic battery, the use of a compound seal formed of a closely-fitting washer formed of non-conducting material, a thin layer or film of paraffine placed over such washer, and a layer of Portland cement or other similar cement pervious to hydrogen gas, but impervious to water or other liquid, superimposed on such washer.

6. In a galvanic battery, the combination of a zinc vessel containing the negative element, the exciting medium, and the seal for confining such exciting medium, and also forming the positive element and its electrode, with a cement seal pervious to hydrogen gas, but impervious to water or other liquid, superimposed upon a non-conducting washer, substantially as described, and for the purposes set forth.

7. In a galvanic battery, the combination of a zinc electrode forming the receiving-vessel for the other parts of the battery, a chloride-of-silver rod, and a compound seal formed of a close fitting non-conducting washer, a film or layer of paraffine spread on such washer for preventing contact of the excitant with the cement, and a superimposed layer of Portland cement or other similar hard porous cement pervious to hydrogen gas, but impervious to water or other liquids, and the circumferential grooves formed in the upper part of the receiving-vessel for the purpose of engaging with the cement seal, substantially as described.

8. In a galvanic battery, the combination of the zinc receiving-vessel Z, forming the positive element of the battery, the chloride-of-silver rod A, forming the negative element, the washers D D′, the silver-foil disks *d d′*, the rubber tubing *b*, and Portland-cement seal F, all substantially as described, and for the purposes specified.

9. In a galvanic battery, the combination of the sealed battery R with the cylindrical chamber O, the contact-spring Q, and the rigid movable base-plate P′, as and for the purposes described.

10. In an electrical apparatus, the combination of a chloride-of-silver battery having an electrode at each end, a movable metallic base or support of such battery permanently connected with one of the line-wires forming the electrical circuit, such base being so arranged as to be in contact with one electrode of the battery, and a metallic spring contact permanently connected with the other line-wire of the circuit, and so arranged as to be in contact with the other electrode of the battery.

Dated this 15th day of September, 1890.

PHILIP HATHAWAY.

Witnesses:
V. I. WILSON,
CHAS. HATHAWAY.

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DEFENDANT'S EXHIBIT No. 8

C. L. VAN TENAC.

DRY ELECTRIC PILES.

No. 184,932. Patented Nov. 28, 1876.

FIG. 3.

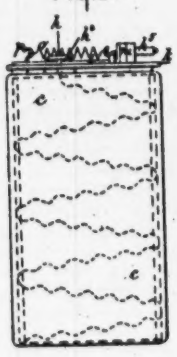


FIG. 4.

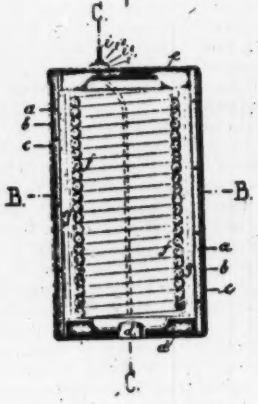


FIG. 6.

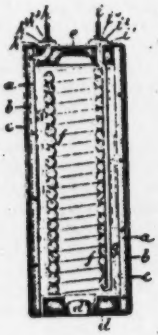


FIG. 1.

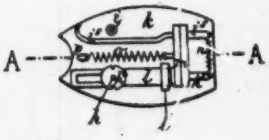


FIG. 5.

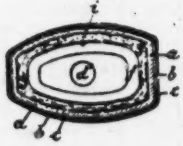
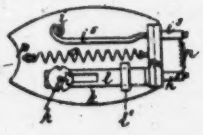


FIG. 2



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Witness R. H. Brandon
Witness D. H. Brandon
Opp. rue Laffitte Paris

Inventor:
Charles Louis Van Tenac

Cabinet de Brandon et M. Brown. 13 rue Gaillon. PARIS

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UNITED STATES PATENT OFFICE.

CHARLES LOUIS VAN TENAC, OF PARIS, FRANCE, ASSIGNOR TO ALEXANDER M. HAYS, OF NEW YORK, N. Y.

IMPROVEMENT IN DRY ELECTRIC PILES.

Specification forming part of Letters Patent No. 184,932, dated November 28, 1876; application filed October 24, 1876.

To all whom it may concern:

Be it known that I, CHARLES LOUIS VAN TENAC, engineer, of No. 1 Rue Lafitte, Paris, France, have invented certain new and useful Improvements in Dry Electric Piles; and I do hereby declare that the following is a full and exact description thereof, reference being made to the accompanying drawings, and the letters of reference marked thereon.

My new pile consists in an outer shell in chloride of silver, within which I place a coil of zinc wire, or a perforated sheet of zinc, reserving a certain space between these two elements, which I fill with blotting-paper, sawdust, sand, or other absorbent material. For the purpose of better insulation, I cover this outer shell with one or two rounds of paper, preferably pasted thereto, and over the paper I pass a tube of soft rubber or other insulating material. I close the two ends with hard-rubber covers, or other hard insulating material, in one of which I make a small opening, which I close hermetically by means of a plug, and through the other I pass two small wires, one of which is the continuation of an undulated silver or platinum wire, incorporated in the chloride-of-silver shell, in which it is wound from bottom to top, and the other constitutes the upper extremity of a similar wire, which runs up from the bottom of the zinc element, in contact with each individual coil of which the latter is composed. Both protrude to a certain distance outside the hard-rubber cover, and are, when required, connected together by a small sliding mechanism attached to the cover aforesaid, and as hereafter described.

The exciting liquid which I make use of is chloride of zinc at from five to ten per cent., or a saturated solution of marine salt. For the purpose of charging my pile after having withdrawn the plug aforesaid, I fill the battery therewith, allowing it to remain therein until the absorbing material aforementioned has been entirely saturated, and then pour out all the remaining liquid and reinsert the plug.

My new pile can be made of any shape or size within reasonable limits; however, in order to produce an available practical result, the inner surface of the chloride-of-silver case should not be less than six square inches, and of that size it is capable of reddening a platinum coil for industrial or other purposes. As it is only brought into action when the circuit is closed, it is of very long duration in consequence of such intermittent action. For instance, it can be made available thirty thousand times, and even more, for producing a light, as it is hereafter explained, without its being necessary to recharge it with the exciting liquid.

In the accompanying drawing I have represented one of my new piles, Figure 1 being a plan thereof with the circuit open; Fig. 2, a similar plan with the circuit closed; Fig. 3, a lateral elevation; Fig. 4, a similar elevation, in section, through A A, Fig. 1; Fig. 5, a plan, in section, through B B, Fig. 4; and Fig. 6, a front elevation, in section, through C C, Fig. 4.

In these figures, *a* is the outer shell, in chloride of silver; *b*, its first insulating-envelope, in paper; and *c*, its outer insulating-envelope, in soft rubber; *d*, the lower cover with its plug *d'*, and *e* the upper cover, both of which are sealed hermetically in their places by means of gutta-percha, cement, or other similar and appropriate material. *f* is the inner element, consisting in a coil of zinc wire placed centrally with the chloride-of-silver case *a*, and separated therefrom by an absorbent material, such as blotting-paper, sawdust, sand, or similar product, *g*, inserted in the space existing between *a* and *f*. *h* and *i* are the poles passing through the cover *e*, the one *h* being connected with the chloride case *a*, and the one *i* with the zinc coil, as shown in Fig. 6. In order to intercept the passage of the liquid where these wires *h* and *i* pass through the cap, I place around each end, on the upper surface of the cap, soft-rubber washers h^1 and i^1, and on these rubber washers metallic washers h^2 and i^2. The wires being screw-threaded, I run down thereon, by means of pliers or otherwise, small nuts h^3 and i^3, which, by compressing the metallic and the soft-rubber washers, produce a tight joint, as required. The pole *h* forms, as aforesaid, the upper extremity of an undulated silver or platinum wire, which is wound round in the chloride of silver from bottom to top, and which is thus

DEFENDANT'S EXHIBIT No. 9

coiled in a mold, wherein the chloride of silver is poured in a liquid state, and when solidified, the undulations of the wire, both on the outer and inner surfaces of the shell, form numerous points of contact, thereby augmenting the development of the electricity, and strengthening the chloride-of-silver shell. For the purpose of further developing the generation of the electricity, I prefer, before placing the covers or wrappers *b* and *c* aforesaid, to cover externally the shell *a* with a sheet of silver-foil. In order to make and break contact, I place on the cover of the pile a plate; *k*, in hard rubber, bone, ivory, or any other appropriate material, fixing it thereto by piercing two small holes therein, through which the poles *h* and *i* pass. A metallic washer, h^4, screwed on *h*, and a metallic cap pinned or soldered on *i*, serve to maintain this plate *k* in its place. On this plate *k* I adapt a metallic slide, *l*, to which I attach a non-conducting cross-bar, *m*, and I pass through this bar the metallic continuation h^3 in the shape of a wire, h^3, and a wire, i^3, terminated at its rear in the shape of a hook, and I connect h^3 and i^3 with a fine platinum wire or coil, *n*. The slide *l* is passed under a guide, *l'*, and is slotted at the place where it is passed over the pole *h*, so that it can be pushed forward (see Fig. 2) until the hook of i^3 comes in contact with the metallic cap on the pole *i*, at which instant, the current being closed, the coil *n* is heated to redness by the passage of the electricity, whereby fire or light may be produced, and, by the removal of this upper mechanism, employed for industrial or scientific purposes. A spiral spring, *o*, one extremity of which is attached to the cross-bar *m*, and the other to a hook, *p*, fixed to the plate *k*, serves to bring the parts in the position shown at Fig. 1, thereby breaking the contact.

I wish it specially to be remarked that in my new pile I reserve a central space or chamber within the zinc coil, for the purpose of receiving or housing the gases formed by the chemical decompositions of the elements of the pile, allowing such to combine in order to react on the elements, thus insuring a long period of duration of the pile and a greater power. I further remark that, by placing the chloride externally and the zinc internally, contrary to previous practice, I obtain a relatively much larger surface of chloride than of zinc, whereby I obtain, in a relatively very small volume, the same power as actually obtained with piles of a considerably larger volume. Again, these piles, being perfectly hermetic and dry, are available for being carried in the pocket, and for producing flame by contact with a wick saturated with an inflammable liquid, or fire by contact with a dry fibrous wick.

Thanks to the general mode of construction of these piles, as above described, they can be made to assume any form or size, and thereby produce any intensity of electricity requisite for any industrial, military, naval, or other purposes, under a smaller compass than other dry piles hitherto known.

Having thus explained the nature of my improvements, and the best means I am acquainted with for carrying the same into practical operation, I claim—

1. In a dry electric pile, the combination, with the external element, of the internal zinc element *f*, constructed of a coil of zinc wire, or a perforated zinc plate, to allow of the passage of the gases formed between the two elements, as shown and described, and for intensifying the electricity produced.

2. The construction of the external chloride-of-silver shell *a* with an internal undulated silver or platinum wire, for the purpose of augmenting the production of the electricity, and of strengthening the shell itself, as above described and illustrated.

3. The bottom *d*, provided with the hole, and with plug *d'*, for charging and recharging the pile, as above described and illustrated.

4. The combination of the parts h^4, *l*, *m*, h^3, i^3, *n*, *l'*, *o*, and *p*, for the purpose of making or breaking contact, as above described and illustrated.

CHARLES LOUIS VAN TENAC.

Witnesses:

F. ELIPPOT,

J. GUENOT.

545

(No Model.)

W. M. FINK.

GALVANIC BATTERY.

No. 434,593. Patented Aug. 19, 1890.

Fig. 4.

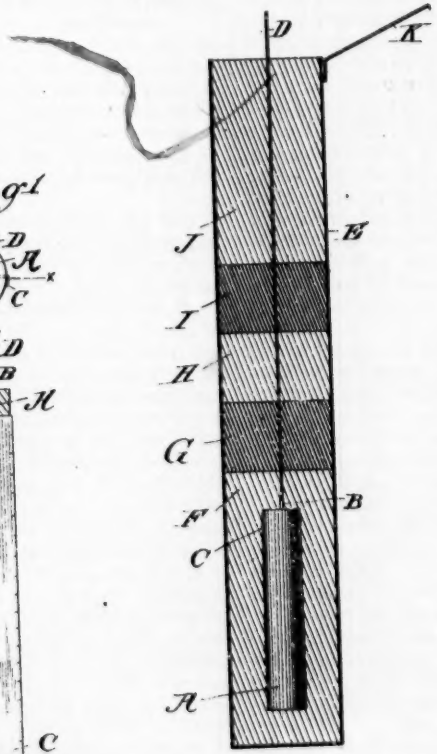

Fig. 1

Fig. 2.

Fig. 3.

Attest:
C. W. Benjamin
Louis Bland.

Inventor.
William M. Fink
by his Attorney
Philip Hathaway.

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UNITED STATES PATENT OFFICE.

WILLIAM M. FINK, OF ELIZABETH, ASSIGNOR OF TWO-THIRDS TO SHERMAN COOPER AND PHILIP HATHAWAY, BOTH OF WESTFIELD, NEW JERSEY.

GALVANIC BATTERY.

SPECIFICATION forming part of Letters Patent No. 434,593, dated August 19, 1890.

Application filed March 19, 1890. Serial No. 344,578. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM M. FINK, a citizen of the United States, and a resident of Elizabeth, in the county of Union and State of New Jersey, have invented certain new and useful Improvements in Electrical Batteries, of which the following is a specification.

My invention relates to that class of batteries in which the negative element is composed of chloride of silver and the positive element of zinc, and usually known as "chloride-of-silver batteries," and the nature of such invention is shown by the following description of the mode in which I construct my improved battery.

I make the zinc electrode of the battery in the form of an elongated hollow vessel, using, by preference, the cylindrical or tubular form as usually most convenient, such vessel or tube being closed at the lower end and open at the top. This zinc tube not only forms in my improved battery the zinc electrode, but also is used as the receiving-vessel for the chloride-of-silver electrode with the exciting-fluid and packing, as hereinafter described. For the negative electrode of the battery I use a rod of chloride of silver, which I construct in the following manner: The chloride of silver is melted and cast in a mold in the form of a rod, round a longitudinal axis formed by a piece of silver wire placed in the center of the mold. Before placing this central wire on the mold I attach thereto a piece of silver-foil of a length slightly exceeding the length of the mold and of a width rather greater than the width of the mold, such foil being slit at the edges, so as to form a series of flaps or projections, which, when the wire is placed in the mold, will be doubled back against the sides or interior circumference of the mold, and will consequently, when the melted chloride of silver is poured into the mold, arrange themselves in various directions around the surface of the rod of chloride of silver formed by the mold and be impacted on such surface. In practice I find it desirable to give the central wire, after the foil is attached thereto, a slight twist, so that the projecting ends of the foil may assume a spiral form around the interior circumference of the mold; or I attach small transverse silver wires to the central wire and allow the same to project to a width slightly exceeding the diameter of the mold, so that the ends of such transverse wires shall be doubled back against the interior circumference of the mold, or I attach to such central wire a strip of thin silver-wire gauze slightly exceeding in the same way the diameter of the mold, the object in each case being to bring the electric current as far as possible into close contact by means of the metallic silver, in the form of foil, wire, or gauze, with every part of the chloride-of-silver rod, and especially with its central parts. By the adoption of this device I have been enabled to remove the principal objection which has hitherto been found in the use of chloride-of-silver batteries, which is that, owing to the fact that chloride of silver is a bad conductor, such batteries are very slow in starting and their initial force very small, for which reason they have been found to be wholly inapplicable for use with bells or annunciators where instant action is needed. In a battery constructed in my improved method it will be found that the electrical action starts the instant that the circuit is closed, and that the full force of the battery is exerted at once—a result which has never hitherto been attained. I am aware that in some chloride-of-silver batteries attempts have been made to remedy this well-known defect by winding silver wire on the external surface of the chloride of silver; but such a device does not effect any complete and sufficient communication throughout the whole body of the chloride-of-silver rod, and especially with its central portions, and they have failed, therefore, adequately to remedy such defect. The zinc tube and the chloride-of-silver rod being thus prepared, I proceed as follows:

I take a suitable vehicle—such as plaster-of-paris—capable of setting and forming when set a dry porous mass, using, preferentially, plaster-of-paris mixed with filtering-paper reduced to pulp, or with absorbent cotton wool, which I mix with water and any suitable exciting medium till it is of the consistency of thick cream, and I fill about two-fifths of the zinc-tube with such vehicle. I then take the rod of chloride of silver having a con-

DEFENDANT'S EXHIBIT No. 10

ducting silver wire of suitable length attached to the central wire of the rod, and after wrapping the chloride-of-silver rod with a piece of tissue-paper well moistened with the exciting-fluid I plunge it into the center of the plaster or compound before described, taking care that every part of the rod is equidistant from the surrounding zinc, and that there is no contact at any part, and I then leave the plaster or compound to set. To facilitate the insertion of the rod and to insure against the possibility of any contact at the bottom of the zinc tube, where, if anywhere, contact would be most likely to take place if great care were not exercised, I find it convenient to insert at the bottom of such zinc tube a small rubber washer before pouring in the plaster-of-paris. When the plaster is set, I pack around the top of such plaster a layer of dry fibrous or porous material capable of readily absorbing moisture, using, preferentially, for this purpose absorbent cotton wool. Above such wool or other dry absorbent packing I insert a layer or a seal of wax, paraffine, or other suitable cement, preferentially using a cement made of equal parts of beeswax, rosin, and asphaltum. On this seal I superimpose a layer of dry plaster-of-paris or other similar absorbent substance, and over this another thick layer or seal of the wax or cement before described. The approximate relative thickness of these various layers is shown in the drawings hereinafter referred to and annexed to this specification. I then attach a wire in the usual way to the upper portion of the zinc tube, and the battery is complete and ready for use. It may then be placed in any suitable case.

For the better understanding of my invention I have annexed to this specification a drawing explanatory of the same, in which—

Figure 1 is a plan view of the chloride-of-silver rod. Fig. 2 is a sectional view of Fig. 1 on the line $x\,x$. Fig. 3 is a view of the silver-foil forming part of the chloride-of-silver rod in a spiral form. Fig. 4 is a longitudinal section of the entire battery.

In the above drawings, A is the chloride of silver; B, the central wire or axis of the chloride-of-silver rod; C, the silver-foil; D, the conducting-wire; E, the zinc tube or containing-vessel; F, the porous filling holding the exciting agent; G, the absorbent cotton packing; H, the wax or cement; I, the dry plaster-of-paris; J, the upper seal or packing of wax or cement, and K the conducting-wire attached to the zinc tube E.

Having thus described the nature of my improvements, what I claim as my invention is—

1. The chloride-of-silver rod A, with central wire B, having attached thereto the silver-foil C or other metallic connections in the shape of transverse silver wires or silver-wire gauze, as described, such foil or other connections being so constructed as to fold over at their points on the surface of the chloride of silver, and to afford complete electrical communication between such surface and the interior portions of the rod.

2. In an electric battery, the combination of a zinc vessel containing the negative electrode and the exciting agent and seal of such battery, and also forming the positive electrode of the battery, a chloride-of-silver rod forming the negative electrode, and a dry porous packing or filling containing the exciting agent, such porous packing or filling being composed of plaster-of-paris mixed with comminuted filtering paper or cotton, wool, or other similar porous fibrous material, all substantially as described.

3. In an electric battery, the combination of a zinc electrode forming the receiving-vessel for the other elements of the battery, a chloride-of-silver rod forming the negative electrode, a dry porous packing or filling containing the exciting agent, and a seal for the battery composed of one or more layers of dry absorbent material alternated with one or more layers of wax or cementing material.

4. In an electric battery, the combination of a zinc vessel forming the positive electrode of the battery, and also holding the other elements of such battery, a chloride-of-silver rod forming the negative electrode, a silver conducting medium embedded in such chloride-of-silver rod, a dry porous packing holding the exciting medium, and a seal composed of alternate layers of dry absorbing material and wax or cement, as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

WILLIAM M. FINK.

Witnesses:

BENJAMIN M. OGDEN,

W. A. MORRELL.

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(No Model.)

J. J. PEARSON.

CARTRIDGE SHELL BATTERY.

No. 512,055. Patented Jan. 2, 1894.

Fig 1.

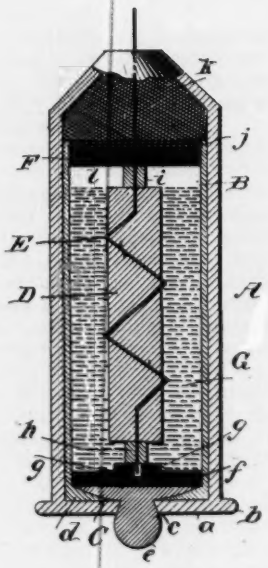
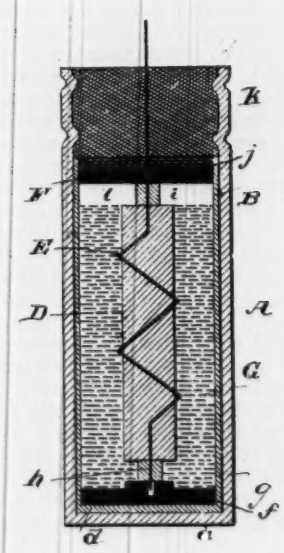


Fig 2.



WITNESSES:

Paul Johst

C. Sedgwick

INVENTOR

J. J. Pearson

By Munn & Co

ATTORNEYS.

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UNITED STATES PATENT OFFICE.

JAMES J. PEARSON, OF BROOKLYN, NEW YORK.

CARTRIDGE-SHELL BATTERY.

SPECIFICATION forming part of Letters Patent No. 512,055, dated January 2, 1894.

Application filed January 28, 1893. Serial No. 460,109. (No model.)

To all whom it may concern:

Be it known that I, JAMES J. PEARSON, of Brooklyn, in the county of Kings and State of New York, have invented a new and Improved Cartridge-Shell Battery, of which the following is a specification, reference being had to the annexed drawings, forming a part thereof, in which—

Figure 1 is a vertical section; and Fig. 2 is a vertical section of a modified form.

Similar letters of reference indicate corresponding parts in both views.

The object of my invention is to construct a simple, compact and powerful sealed battery, which will be inexpensive in its construction and adapted to all of the uses to which such batteries may be applied.

My invention consists in an outer casing or envelope, preferably a cartridge shell, such as is used in the manufacture of cartridges for firearms, a cylindrical lining of zinc or other electro-positive material, a cylinder of silver chloride forming the negative element supported by elastic insulating disks, an electrolytic body interposed between the chloride of silver cylinder and the zinc lining, a hermetic seal closing the open end of the shell, and a silver wire extending through the seal and passing in a zigzag direction through the silver chloride cylinder, the open end of the shell being contracted or grooved to retain the contents, all as will be hereinafter more fully described.

The shell A, which forms the outer envelope or cell of the battery, consists of a cartridge shell such as is used in firearms, made in the form of a hollow cylinder, with a head *a* with or without the flange *b*, and having at the center thereof a cap opening *c*. In the said shell A, is inserted or deposited a lining B, of zinc or other suitable material, the said lining covering the bottom of the shell. In the bottom of the zinc lining B, may or may not be inserted a button C, which projects through the cap aperture *c*, forming a contact knob *e*, which is compressed upon the head *a*, making a tight joint between the said button and the head.

Upon the bottom of the cell is placed a disk *f*, of elastic rubber or analogous material, which is provided at the center with a boss, bored for a short depth, but not through, to admit the end of the wire E. On this boss rests a cylinder D, of silver chloride, a sleeve *h* acting as a thimble or spacer between the silver chloride cylinder D and the disk *f*, which yields or expands to allow for any expansion or contraction of the shell A, which would otherwise rupture the seal.

The silver chloride is cast upon a wire E, which passes through the cylinder of chloride of silver in a zigzag direction, the said wire protruding through the ends of the silver chloride cylinder in the line of its axis, and extending through the sleeve *h*, and into, but not through the disk *f*. The upper end of the silver wire E passes out of the cylinder D at its axis, and extends beyond the open end of the shell A.

On the top of the silver chloride cylinder D, is placed a short elastic sleeve *i*, and upon this rests a disk F, of soft rubber or analogous material, which fits the zinc lining B. Above the disk F is placed a layer *j* of elastic cement, and upon this layer is placed a solid capping seal *k* of hard cement, the shell A being grooved circumferentially as in Fig. 2, or contracted conically, as in Fig. 1, at the end, before the insertion of the hard cement. In the cell thus formed, before it is closed, is placed the electrolytic material G, which fills the space between the silver chloride cylinder and the zinc lining, leaving a gas chamber *l* at the top, to receive such small amount of gas as may be generated in the working of the battery.

The connection of the cell with the translating devices is effected by bringing the conductors into contact with any part of the shell A, or what is to be preferred, with the projection *e* of the button C, and with the protruding end of the silver wire E. The wire E, in addition to being made in zigzag form, may be twisted spirally, or so shaped that it securely holds the chloride of silver which is cast around it.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. A battery, formed of an outer protecting shell A, a zinc lining B, a silver chloride cylinder D, furnished with a zigzag wire E, for

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supporting the silver chloride cylinder, elastic supports for the cylinder which compensate for the expansion and contraction of the shell, electrolytic material placed in the shell and surrounding the silver chloride cylinder, leaving a gas chamber, and a seal for closing the end of the battery cell, formed partly of elastic material and partly of inelastic material, substantially as specified.

2. A negative element for a galvanic battery, formed of a body of silver chloride, and a zigzag silver wire inclosed in the silver chloride, with the apexes of the angles of the silver wire near the surface of the body of silver chloride, the ends of the silver wire protruding from the body of silver chloride and forming supports for the same, substantially as specified.

JAMES J. PEARSON.

Witnesses:
GEO. M. HOPKINS,
C. SEDGWICK.

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[fol. 806] IN THE UNITED STATES COURT OF CLAIMS

DEFENDANT'S EXHIBIT No. 11

PRACTICAL PRIMARY CELLS

By

Arthur Mortimer Codd, F.Ph.S.

Member of the Röntgen Society

Author of "Induction Coil Design", "Electric Ignition for Internal Combustion Engines", "Electric Lighting, Starting, and Ignition for Motor Vehicles", "Electric Wiring Diagrams for Motor Vehicles"

London
Sir Isaac Pitman & Sons, Ltd.
Parker Street, Kingsway, W.C.2
Bath, Melbourne, Toronto, New York
1929

[fol. 807] PRACTICAL PRIMARY CELLS

CHAPTER I

The Simple Voltaic Cell

The earliest primary cell is the simple element devised by Volta in 1793. This consists of a vessel containing dilute acid, in this case dilute sulphuric acid, into which dip two strips of metal, one of zinc, the other of copper (Fig. 1). The liquid is called the electrolyte, and the strips the electrodes.

When these metal plates are introduced into the electrolyte the copper plate shows no apparent action, but the zinc will be attacked by the sulphuric acid giving off bubbles of hydrogen at the zinc plate and forming zinc sulphate in the solution.

If a sensitive voltmeter be applied between the ends of the strips there will be found to exist between them a difference of pressure of about 1 volt.

The ends of the strips projecting above the electrolyte may be regarded as the poles of the cell, and the voltmeter (if a moving coil instrument) will show that the copper strip forms the positive or + pole, and the zinc strip the negative or − pole, that is, current is flowing through the voltmeter or exterior circuit from the copper to the zinc electrode.

If, however, we regard the flow of current from the point of view of the interior of the cell we see the current is flowing from the zinc to the copper, that is, the zinc is electro-positive to the copper, whereas the copper is electro-negative to the zinc.

[fol. 808] If we substitute for the electro-positive electrode or zinc a plate of magnesium we shall obtain a voltage of the order of 1·7 volts, if aluminum is used a voltage of about ·45, or with iron about ·4 volts.

Suppose now we remove the copper electrode and substitute a carbon plate; using the original zinc we get a voltage of 1·04, with magnesium a voltage of about 1·9, with aluminum about ·59, and with iron ·52 volts.

From this we see some metals or bodies are more electro-positive than others, and also in relation to themselves.

In this way we can build up a relative table of chemical

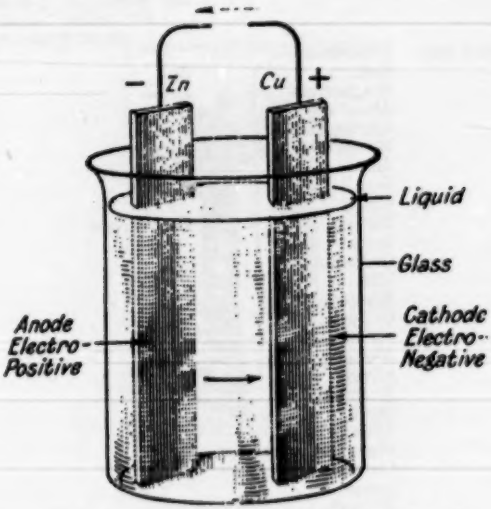

FIG. 1. SIMPLE VOLTAIC CELL

elements arranged in their various relationships one to another, as shown on page 3.

We observe from this table that iron is electro-positive to lead and nickel to gold, etc., so that the farther apart we can choose our electrodes, other things being compatible, the greater the electrical pressure the cell will generate.

[fol. 809] ELECTRO-CHEMICAL SERIES*

		Difference in potential in air for various metal couples (Ayrton and Perry)	
Electro-positive end—	Potassium		
	Sodium	Zinc	.210
	Magnesium	Lead	
	Aluminum	Tin	.069
	Chromium	Iron	.313
	Manganese	Copper	.146
	Zinc	Platinum	.238
	Iron	Carbon	.113
	Cobalt		
	Nickel	Zinc carbon = ...	1.089
	Lead		
	Cadmium		
	Tin		
	Bismuth		
	Copper		
	Hydrogen		
	Mercury		
	Silver		
	Antimony		
	Gold		
	Iridium		
	Platinum		
	Carbon		
	Boron		
	Nitrogen		
	Arsenic		
	Selenium		
	Phosphorus		
	Sulphur		
	Iodine		
	Bromine		
	Chlorine		
	Oxygen		
Electro-negative end—	Fluorine		

*Some rarer elements are omitted for brevity. It should be noted also that the series vary slightly under different conditions.

Returning to our zinc-sulphuric acid-copper cell, we have seen that it generates on open circuit a pressure of about 1 volt.

* * * * * * *

[fol. 810] dispensed with, causing a consequent lowering of the I.R. of the cell. As the cell approaches the end of its life the clear zone expands, the ferric chloride becoming reduced and assuming a watery yellowish colour. At this point the cell can readily be cleaned by rinsing it under

the tap, and recharged with ferric chloride, as the zinc is sufficiently robust to last out several charges of ferric chloride.

Fig. 16. Codd Cell Complete

As the capacity of the cell in ampere-hours depends on the volume of its contents, the cells are usually made square or rectangular to economize shelf space (Fig. 16), and also for convenience in the packing. These cells are capable of giving considerable currents for long periods; thus, a 3-pint cell will give ¼ amp. for 300 hours continuously, or double that or more for periods of 4 to 5 hours daily at an average P.D. of about 1·2 volts. For ordinary purposes the cell is demed exhausted when it falls to a P.D. of 1 volt. Such cells work small glow-lamps, wireless valve filaments, etc., entirely satisfactorily, as well as furnishing weaker currents for open-circuit work, such as electric clocks, bells, etc., and are very cheap and easy to maintain.

Miscellaneous Cells. To conclude this section, some allusion must be made to the cells devised by Marié Davy, Schanschieff, and De la Rue.

In the Marié Davy cell the elements are disposed in a horizontal direction, the carbon plate lying at the bottom of the cell, which is trough-like in shape. Above the carbon is placed a similar size plate of zinc, the space between [fol. 811] them being filled with mercurous sulphate and the cell filled with water. The action is as follows: the zinc

combines with the sulphuric acid contained in the mercurous sulphate, forming zinc sulphate and freeing metallic mercury. Some of this mercury goes to amalgamate the zinc plate, the rest falls to the bottom of the cell. Marié Davy also constructed a two-fluid form of this cell, the carbon with its mercurous sulphate being in the outer vessel, and the zinc within the porous pot in a dilute acid solution. The E.M.F. of these cells is about 1·5 volts, but they are rather feeble in action.

Schanschieff modified this cell by arranging the electrodes as a single-fluid cell in the orthodox position, using a zinc plate between two carbons, and also by using a specially-prepared mercury salt made by repeatedly dissolving metallic mercury in boiling sulphuric acid, the resulting salt being apparently a special acid form of mercuric sulphate. Very fair results can be obtained by using ordinary mercuric sulphate dissolved in sodium bisulphate or other suitable vehicles.

The cell is very clean to use, but in the writer's experience metallic mercury is liable to be deposited on the zinc, even on open circuit, so that the cell soon exhausts itself. Mercury salts are also very poisonous, and their high price renders the cell commercially out of court.

Cells similar to the above, but constructed with special precautions as to the disposition and purity of the materials employed, form the basis of the standard cells of Clark, Rayleigh, Carhart, and others.

The cell devised by De la Rue consists of a mixture of silver chloride, AgCl, fused round a central silver wire, the anode being zinc and the excitant a solution of salt (NaCl). Briefly, the salt acts on the zinc when the circuit is closed, forming zinc chloride, the hydrogen freed combines with the chlorine in the silver chloride to form hydrochloric acid, and silver is deposited on the silver cathode.

* * * * * * *

[fol. 812] words, for the higher rate of discharge a larger cell is necessary for true economy.

Another concrete example is given in Fig. 38, by curves supplied by Messrs. Siemens Bros., of the discharge of one of their low-resistance circular cells, 2⅝ in. in diameter, and 6¾ in. high (Fig. 39). Here the capacity falls from

about 62 amp.-hr. when discharged at ·125 amp., to 41 amp.-hr. approximately when the current is increased to ·25 amp.

FIG. 39.
SIEMENS LOW RESISTANCE CELL (CIRCULAR)

From these results the necessity of choosing a cell of ample size for the duty imposed can be realize, and this is particularly the case with such small cells as are used for flash-lamp purposes or for wireless high-tension batteries. It is not easy to obtain figures of discharge rates for these latter, because so much depends on circumstances, that is, on the total current taken by the set and on the periods of use and of repose. Taking these as being normal, Messrs. Hellesen publish the tables given on the next page as a guide.

Inert Cells.

Before terminating this chapter, mention must be made of an important branch of dry cells, that is, the inert cell, which is virtually a dry cell put up without the moist paste in place, and with one of the vent holes enlarged to form an opening large enough to carry a small cork (Fig. 40). Although the paste is omitted as such, the excitant salts are left in place within the cell, and in some cases the desiccated components of the jelly. Under these conditions the cell will store in good condition for very long periods, and when it is required to put the cell in action it is only necessary to add water through the vent (having removed the cork) till the cell is full, using for the purpose a small glass syringe similar to that used to fill a fountain pen.

[fol. 813]

STANDARD CAPACITY

(Maximum Discharge Advised—8 MA.)

Periods of Use	Rate of Discharge in Milliamperes			
	5	10	15	20
	Life in Hours			
30 hours per week	320	140	85	60
40 " "	300	130	80	55
50 " "	280	125	75	55
60 " "	250	115	70	50

DOUBLE CAPACITY

(Maximum Discharge Advised—12 MA.)

Periods of Use	Rate of Discharge in Milliamperes			
	5	10	15	20
	Life in Hours			
30 hours per week	550	260	165	120
40 " "	540	255	160	115
50 " "	520	250	160	110
60 " "	500	250	155	100

TREBLE CAPACITY

(Maximum Discharge Advised—20 MA.)

Periods of Use	Rate of Discharge in Milliamperes		
	10	15	20
	Life in Hours		
30 hours per week	430	280	200
40 " "	420	270	195
50 " "	410	260	185
60 " "	400	250	170

[fol. 814] After the cell has stood for some time the excess of moisture, if any, can be shaken out, and the cell, re-corked, is ready for use. Cells of this sort should, in general, be used standing up, although for short periods they may be used in any position.

The advantages of cells of this description for long storage or for tropical use are apparent, since deterioration does not begin till the cell is actually in use, hence, the reliability of the cell is greatly increased.

Messrs. Siemens Bros. have used this principle in the manufacture of small torch batteries (Fig. 41). On receiving the cells it is only necessary to remove the cork and to fill with water as above outlined, allowing the cells to stand for 24 hours. In this case, however, the small [fol. 815] cork is not replaced, but a composition cork disc, or washer, having a central hole to fit the carbon, is forced

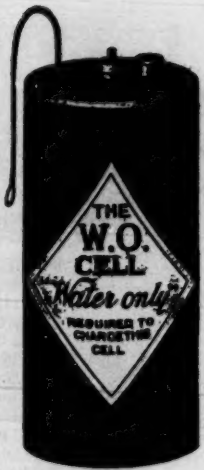

FIG. 40. INERT CELL
Atlas Carbon & Battery Co., Type W.O. (Water only)

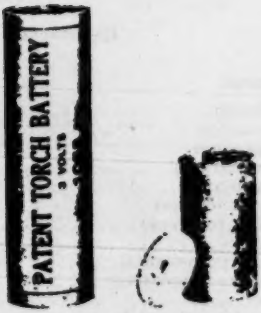

FIG. 41. SIEMENS INERT FLASH LAMP CELL

in place within the edge of the zinc cylinder, thus sealing the cell. Paraffin wax may be melted over the cork as an additional safeguard if desired. Thus charged, one is in possession of a battery as fresh as if just manufactured.

• • • • • • •

[fol. 816]

Useful Data

1 Pint of Water { = 20 fluid ounces.
= 20 ounces avoirdupois.
= 34.68 cubic inches.
= 568.24 cubic centimetres.

Electro-chemical Equivalents

Element	Grammes deposited per ampere-second
Hydrogen	.000010384
Aluminium	.0000932
Magnesium	.0001242
Iron (ferrous)	.0002902
Iron (ferric)	.0001935
Copper (cupric)	.0003281
Copper (cuprous)	.0006562
Zinc	.00033698
Mercury (mercuric)	.0010374
Mercury (mercurous)	.0020748
Silver	.0011181
Tin (stannic)	.0003058
Tin (stannous)	.0006116
Lead	.0010716
Nickel	.0003043

Table of Solubility in 100 Parts

(of common battery salts)

(The values given below are approximate and depend upon temperature.)

Alum (potassium)	5.63
" (sodium)	103.1
Ammonium carbonate	100
" chloride	29.4
Calcium chloride	117.4
Chromic acid (trioxide)	163.4
Copper nitrate	243.7
" sulphate	32.96
Ferric chloride	246
" nitrate	V. soluble

* * * * * * *

[fol. 817]

	Anode	Solution and Depolarizer (if any)	Cathode	E.M.F.	Date
			C		1886
Torregiani	Pb	Solution of potassium carbonate	Ag^{Pt}	.5	
Tyer	Zn	Dilute H_2SO_4	Cu	.9	1800
Volta, also Cruikshank, Children, Wollaston	Zn	Dilute H_2SO_4	C^{Pt}		1859
Walker	Zn	Solution H_2SO_4	Cu		
Weare	Zn	Solution H_2SO_4 in straw or paper pulp	C		
Zaliwski also Cauderay, Palagi	Zn	Salt solution	C		1869
Zaliwski	Cu	Solution H_2SO_4 and HNO_3			
		SINGLE-FLUID CELLS WITH SOLID DEPOLARIZER			
			C	.59	1846
Becquerel	Zn	Solution salt. P.P. solution salt with lead sulphate	Fe		1883
Bennet (a.d.)	Zn	Solution caustic potash P.P. Iron turnings	C	1.2	1874
Clamond	Zn	Solution AmCl. P.P. ferric oxide and crushed carbon	Ag	1.15	1881
D'Arsonval	Zn	Solution Zinc chloride P.P. silver nitrate	Ag	1.03	1868
De la Rue	Zn	Solution AmCl or salt. Silver chloride used round	C		
" "	Zn	MnO_2	Pt	2.4	1843
De La Rive	Zn	Dilute H_2SO_4 P.P. lead peroxide	Cu		1870
Denys	Zn	Salt or acid solution. P.P. dilute H_2SO_4 cupric oxide			
Fabri et Ravaglia (a.d.)	Zn	Caustic potash P.P. crushed carbon	C	1.6	1884
Féry (a.d.) also le Carbone	Zn	Solution AmCl. Special porous	C	1.4	
Fortin (a.d.) also Devos, Weber	Zn	Solution AmCl P.P., crushed carbon	C	1.08	
Gaiffe	Zn	Solution zinc chloride. Silver chloride fused round	Ag	1.02	

Patented Dec. 25, 1928. 1,696,873

UNITED STATES PATENT OFFICE.

ROBERT T. WOOD, OF NIAGARA FALLS, NEW YORK, ASSIGNOR TO AMERICAN MAGNESIUM CORPORATION, A CORPORATION OF NEW YORK.

MAGNESIUM PRIMARY CELL.

No Drawing. Application filed August 5, 1925. Serial No. 48,385.

The invention relates to primary, or voltaic, cells or batteries of either the wet or so-called "dry" type, which make use of a substantially neutral electrolyte in connection with suitable electrodes.

It would seem that a relatively high voltage primary cell would be obtained by using a suitable positive electrode with magnesium as the negative electrode and I am aware that attempts have been made to develop such a cell. As far as I am aware, however, these have all been unsuccessful, and it has been generally accepted that magnesium could not be commercially utilized as a primary cell electrode.

One object of the invention is to make feasible the use of magnesium or magnesium base alloys as a negative electrode in primary cells by minimizing corrosion of the metal on open circuit, so that the cell will compare favorably in life with the common "dry cell" or the Leclanché cell.

Another object of the invention is to provide a cell which develops a substantially higher voltage than the Leclanché cell or the usual "dry cell".

These objects are rendered feasible and commercially practicable by the use of a suitable and novel electrolyte, whose advantages and use will be described more fully in the following specification.

The Leclanché cell makes use of a negative electrode of zinc and a positive one of carbon in conjunction with an electrolyte containing ammonium chloride. In order to maintain the voltage of the cell during use, a depolarizer, such as solid manganese dioxide, is used.

This type of cell is used extensively for so-called open circuit work, where the battery is not required constantly to supply a current, such uses being bell circuits, gasoline engine ignition, etc. In the most common form it is made up as the well-known "dry" cell.

Magnesium stands near the top of the electrochemical series and because of its high solution potential a much higher voltage should be produced if the zinc of the Leclanché cell is replaced by magnesium. However, magnesium will corrode so rapidly in ammonium chloride solution that the cell becomes valueless in a few hours, even on open circuit. The same disadvantage applies to all the commercially used primary cell electrolytes.

I have discovered, however, that this corrosion of magnesium or magnesium base alloys will be greatly decreased or even practically inhibited by the use of an electrolyte which contains one or more strong oxidizing agents in solution. The amount of protection offered by the use of such an electrolyte depends upon the composition of the solution and the oxidizing agent utilized. In general, it may be said that a substantially neutral or basic electrolyte is more effective for this purpose than is one which shows an acid reaction.

I have found that salts of chromic acid, particularly sodium and potassium dichromates, and the nitrates of the alkali and alkaline earth metals are especially effective for reducing electro-chemical corrosion of magnesium or magnesium base alloys. With the alkali metals I include also the ammonium radical, which behaves much like them in certain reactions and is generally classed with them for analytical purposes.

The base of the electrolyte in which the oxidizing agent is dissolved may be an aqueous solution of any of a large number of chemical compounds. The chlorides of the alkali and alkaline earth metals and the sulphates and chlorates of the alkali metals are particularly suitable.

As an example of an electrolyte suitable for the performance of my invention, and which will not corrode magnesium appreciably on open circuit, the following compositions may be given:—

	Parts by weight.
Ammonium chloride	2
Ammonium nitrate	1
Sodium dichromate	1
Water	8

In order to maintain the voltage of the cell, I preferably use manganese dioxide as a depolarizer in the usual manner. A cell composed of this electrolyte in conjunction with carbon and pure magnesium electrodes

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will develop about 2 volts as compared with 1.6 volts for carbon and zinc electrodes in the ordinary Leclanché cell.

The following examples demonstrate the efficacy of my electrolyte as compared with the common ammonium chloride solution:

Two simple cells were constructed, one electrode of each being a carbon rod seven-eighths inch in diameter. The other electrode of each was a piece of commercially pure magnesium sheet, one inch wide and 0.05 inch thick. A solution of 25 grams ammonium chloride in 100 cc. water was placed in one cell; the electrolyte in the other was made up according to the preferred proportions given above. The amount of solutions was such that all electrodes were immersed to a depth of one inch.

The magnesium electrode in the simple ammonium chloride solution was attacked immediately by the electrolyte, and there was a very brisk evolution of gas, which possessed the odor characteristic of ammonia. After four hours' immersion half of the portion in the solution had been eaten entirely away, and the remainder was but 0.006 inches thick and penetrated by many holes.

On the other hand, the magnesium electrode immersed in the electrolyte made up in accordance with my invention was not visibly attacked. The evolution of gas was so slight as to be almost imperceptible and no diminution in thickness could be detected with a micrometer after 24 hours, nor was any pitting visible. This cell developed a potential of 1.4 volts, measured on open circuit, and the straight ammonium chloride cell, measured in the same manner, produced 1.5 volts.

By applying a pasty mass of finely powdered manganese dioxide to the carbon electrodes, the cell made up in accordance with my invention showed an electromotive force of 2.0 volts on open circuit, and the other cell generated 2.2 volts. An ordinary dry cell will develop about 1.6 volts.

The lower voltage of my cell as compared with one made by using carbon and magnesium electrodes in a solution of ammonium chloride appears to be due to the presence of oxidising agents in solution, which tend to lower somewhat the solution tension of metallic electrodes immersed therein and therefore lower the theoretical voltage of the cell. Metallic magnesium, however, has such a high solution tension that even with the concentrations of oxidising agents necessary to inhibit corrosion, the cell will still develop a higher voltage than one containing another metal, such as zinc, in place of magnesium.

It is well known in the art that metals or alloys used as electrodes should be as free as possible from impurities or constituents which form galvanic local couples in the presence of an electrolyte. Such couples enhance greatly local corrosion of the electrode, thereby shortening the life of the cell. This requirement applies to all metallic electrode material and equally well to magnesium and its alloys. Likewise the electrolyte should not contain metals which are capable of being precipitated as such on the magnesium electrode, as these also will cause local action.

Magnesium base alloys which are resistant to corrosion can be employed in my cells and I have found magnesium base alloys containing aluminum and manganese to be particularly applicable.

It will be apparent that other electrolyte compositions may be applied than that described and other oxidising agents may be utilized without departing from the spirit of the invention, the aforementioned compositions being cited not as limitations, but merely as examples suitable for the accomplishment of my invention.

In using the term "magnesium" in the claims, I comprehend not only the pure metal, as commercially produced, but also such alloys, composed chiefly of magnesium, as lend themselves to the same use.

I claim:

1. A primary cell comprising an electrode of magnesium and a neutral electrolyte containing a strong soluble oxidising agent adapted to reduce the rate of corrosion of the magnesium electrode on open circuit.

2. A primary cell comprising an electrode of magnesium and a neutral electrolyte containing a salt of chromic acid adapted to reduce the rate of corrosion of the magnesium electrode on open circuit.

3. A primary cell comprising an electrode of magnesium and a neutral electrolyte containing the dichromate of an alkali metal adapted to reduce the rate of corrosion of the magnesium electrode on open circuit.

4. A primary cell comprising an electrode of magnesium and a neutral electrolyte containing salts of chromic and nitric acids adapted to reduce the rate of corrosion of the magnesium electrode on open circuit.

5. A primary cell comprising an electrode of magnesium and a neutral electrolyte containing the dichromate of an alkali metal and the nitrate of an alkali metal adapted to reduce the rate of corrosion of the magnesium electrode on open circuit.

6. A primary cell comprising a negative electrode of magnesium and a substantially neutral solution of an oxidizing agent in contact therewith adapted to reduce the rate of corrosion of the said electrode on open circuit.

7. A primary cell comprising an electrode of magnesium and an electrolyte containing ammonium chloride and sodium dichromate.

8. A primary cell comprising an electrode

of magnesium and an electrolyte containing ammonium chloride, ammonium nitrate and sodium dichromate.

9. A primary cell comprising a negative electrode of magnesium and an electrolyte having as its base a substantially neutral reagent, which on open circuit will rapidly corrode magnesium, the said electrolyte containing in addition to the said base another reagent which causes a reduction in the rate of corrosion of the said electrode on open circuit.

In testimony whereof I affix my signature.

ROBERT T. WOOD.

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DEFENDANT'S EXHIBIT NO. 13

July 25, 1933. S. RUBEN 1,920,151

POTENTIAL PRODUCING CELL

Filed April 22, 1933

FIG.1.

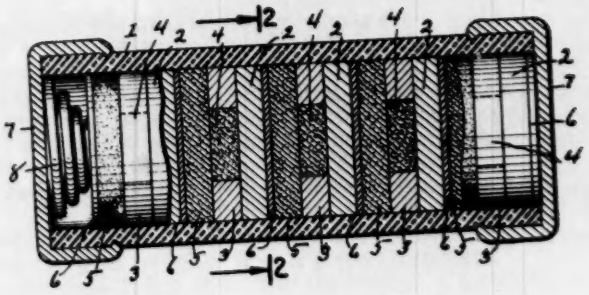
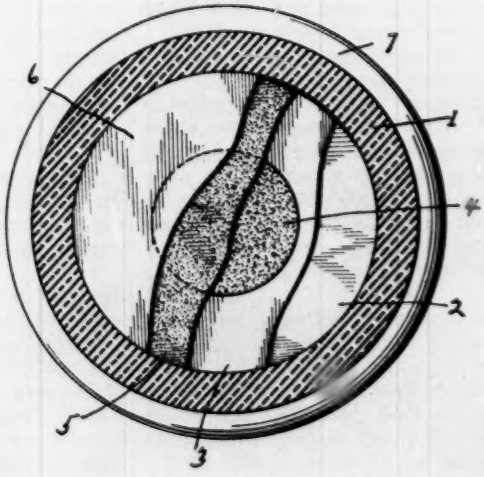


FIG.2.



INVENTOR
SAMUEL RUBEN
BY
ATTORNEY

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Patented July 25, 1933 1,920,151

UNITED STATES PATENT OFFICE

SAMUEL RUBEN, OF NEW ROCHELLE, NEW YORK

POTENTIAL PRODUCING CELL

Application filed April 22, 1933. Serial No. 667,491.

This invention relates to a device for producing a constant potential and this application is a continuation in part of my pending application Ser. No. 688,607 filed September 17, 1932.

An object of the invention is to provide a potential producing cell having no appreciable internal chemical action for the production of current and having a long life.

Another object is the provision of a cell for producing a constant potential in which the electrodes, particularly the cathode, are substantially unaffected and not consumed by the electrolyte.

A specific object is the provision of a device for negatively biasing the grid or control element of electron discharge tubes or other electrostatically operated devices requiring no current; to provide a device of this character which suffers no material change or deterioration in performance due to local or shelf action.

Other objects will be apparent from the disclosure.

Broadly, the invention utilizes the contact potential difference between electrodes of an electro positive material such as aluminum and an electronically conductive relatively electro-negative material such as iron oxide, with a non-reacting electrolyte in which the cathode is not substantially soluble, such as ethylene glycol or glycerine.

A typical cell is shown in the accompanying drawing illustrating an embodiment of my invention, Fig. 1 showing a device partially cut away and Fig. 2 showing a sectional view on line 2—2.

Heretofore, where a line potential has not been used, a primary battery has been employed for negatively biasing the grids of vacuum tubes. These batteries have the disadvantage of deteriorating with and without use, the cathode chemically reacting with the electrolyte at all times. The consequent decrease in potential means a loss of usefulness, irrespective of the fact that a negatively biased grid circuit is not required under normal conditions, to supply direct current.

In the present invention, I employ as the cathode, a material which is preferably highly electro-positive, for instance, aluminum, magnesium, beryllium, cadmium, zinc or an alloy or amalgam of one or more of these metals. As the anode, I employ an electronically conductive material which is relatively electro-negative with respect to the cathode. Among the materials suitable for such use may be mentioned the electronically conductive oxides, for instance a copper oxide such as cuprous oxide, an iron oxide such as the black magnetic oxide of iron, a lead oxide such as lead peroxide, a vanadium oxide such as the vanadium pentoxide, cadmium oxide; also, carbon, carbonized nickel, carbonized iron, the conductive carbides, etc.

The contact potential built up is dependent upon the electro-chemical dissimilarity between the cathode and anode materials with a given electrolyte.

For the organic electrolyte, which is preferably slightly acidic and which serves as the sole electrical contacting means between the cathode and anode and which is preferably housed in a porous absorbent medium, I prefer a viscous polyhydric alcohol falling within the classes glycols and glycerols. This electrolyte should be substantially free of reactive salts, acids or alkalis in order to avoid injurious local action.

Ethylene glycol is preferred for this use. Its electro-chemical character of low ionization and its low vapor pressure permits its absorption by a filler material such as an absorbent paper. It has a further value because it retains its viscous or liquid state with substantially no drying out, a viscous or plastic electrolyte being highly desirable. Benzols, acetones and other non-reactive organic electrolytes may also be used in combination with electrodes with which they do not react.

In the present invention, no observable chemical reaction takes place between the electrolyte and cathode; if one does take place, it is of such negligible character as to be not harmful and of no substantial effect toward shortening the life of the cell, which life appears to be practically limitless. In the battery art, the function of the cathode has been that of generating a potential and current supply by virtue of its electro-chemical decomposition by and its combining with the electrolyte. Thus, zinc dissolves into ammonia chloride or sulfuric acid to form zinc chloride or zinc sulfate, the current generated governing the rate of cathode consumption. For this reason, a chemically reactive salt is necessary to gen-

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erate a current of any practical magnitude. The device of my invention distinguishes from electrolytic condensers in several ways. These condensers involve ionic action by the effect of applied potentials. The ionic movement or direction is dependent upon the potential or polarity applied. In the present device, the ionic action is due to hydrogen or hydroxyl ion content of the electrolyte and the electro-chemical dissimilarity of materials. The rate of ionic movement is due to generated potential difference and loss of charge. Electrolytic condensers, under the influence of potentials, develop a polarized insulating condition of the anode whereas in the present device, no polarized anode insulating condition obtains. In electrolytic condensers the anode is the electro-positive element as distinguished from the electro-negative element of the present device. It is also well known in the electrolytic condenser art that the electrodes should be similar or as nearly similar as possible in order to avoid electro-potential effects.

The function of the cell of this invention is only to produce a potential and it is of use chiefly where electrostatic control is desired. This is due to the substantially chemically non-reactive character of the electrolyte, its limited ionization and high specific resistance. An attempt to discharge current through it would result in the complete elimination of potential as the electrolyte could not electro-chemically dissolve or react with the cathode at an appreciable rate.

In the cell of my invention, the internal resistance of the cell is sufficiently high to prevent any appreciable current flow. This precludes the use of the cell as a current supply source, that is, as a primary battery cell. This difference may be further emphasized by comparison of the relative resistance values of the electrolyte. The electrolyte of my invention has a resistance many thousands of times that of the electrolyte of the usual primary cell. This is apparent when the resistances of electrolytes used in the various voltaic cells such as the Edison-Lalande, Daniell, gravity, silver chloride, dry cell, Leclanché, Grove, Bunsen, bichromate, storage, Clark or Weston.

Under ordinary applications, the use of ethylene glycol or glycerine is ample. When a high potential is to be produced by a large number of couples in series, it may be of advantage to use an electrolyte of the glycol borate or glycerol borate classes, or other similar compound. Such an eletrolyte may be formed by heating boric acid in ethylene glycol or glycerine until completely dissolved, when the glycol or glycerol borate is probably formed. I have been able to add as high as twenty per cent boric acid to ethylene glycol for this purpose, but prefer to keep the proportion around five per cent.

The addition of the borate allows a slight increase in ionization of the electrolyte which compensates for surface leakage effect which may develop when a number of units are operated in series.

When permanent or long life of the cell is not a primary requisite, a very small or fractional per cent of one of the weak organic acids, such as lactic, malic, tartaric, may be used instead of the boric acid, to form a corresponding slightly acidic polyhydric alcohol compound. While the cathode is not materially attacked or reduced if the percentage of such acid is low enough, there is eventually some small attack and dissolution.

As magnesium is not chemically attacked by alkaline solutions, a cell can also be constructed by using a cathode of magnesium or other suitable material and substituting a somewhat viscous alkaline solution for the glycol or glycerol borate. I have constructed cells of this type and found them satisfactory. One of the most efficient, is a cell comprising an anode of lead peroxide, an electrolyte of an alkaline sodium silicate solution and a cathode of magnesium.

In Figures 1 and 2 of the drawing, a tube (1) constructed of fibre or other suitable material houses a series of voltaic cells each composed of aluminum cathode discs (2), vanadium pentoxide anode (5) and ethylene glycol (containing about 5% boric acid) impregnated cotton plugs (4) which afford the necessary electrical contact between the cathode (2) and the anode (5). The plugs (4) are disposed within sealing washers (3) which are of rubber, paraffined paper or other material adapted to prevent leakage of the glycol or absorption of moisture from the atmosphere. Lead washers (6) space and contact the couples which are maintained under constant pressure by a spring (8) and metal caps (7) which close the device.

I may substitute for each ethylene glycol impregnated cotton plug, a plug or disc of paper or cloth impregnated with ethylene glycol or I may use a disc or plug of regenerated cellulose sheet material, such as is popularly designated "cellophane", which has been plasticized or impregnated with a heavy glycercine or glycol content.

The voltage output of the device is dependent upon the number of couples in series. For variable voltages, the device may be tapped at different points.

The areas of the junctions are such that when in an alternating current circuit, as in the biasing of an audio amplifier, the inter-element capacity of the couple is adequate to introduce a reactance in the grid circuit.

When the device is used as a grid biasing battery in a vacuum tube circuit, it is possible to dispense with the grid leak element.

I claim:

1. A potential supplying battery, comprising a cathode composed of at least one element chosen from the empirical group including aluminum, zinc, magnesium, beryllium and cadmium, an anode of an electronically conductive material electro negative with respect to said cathode, and a contacting electrolyte chosen from the class comprising glycol borates and glycerol borates.

2. In a voltage operated apparatus requiring substantially no current, a potential supplying battery, comprising a cathode composed of at least one element chosen from the empirical group including aluminum, zinc, magnesium, beryllium and cadmium, an anode composed of an electronically conductive oxide of vanadium, and a contacting organic electrolyte with which the cathode does not substantially chemically react, the cathode being substantially insoluble in said electrolyte, said cell having no appreciable internal chemical action for the production of current.

3. A potential supplying battery, comprising a cathod composed of at least one element chosen from the empirical group including aluminum, zinc, magnesium, beryllium and cadmium, an anode chosen from the group of oxides comprising lead peroxide, iron oxide, cadmium oxide, vanadium pentoxide and cuprous oxide, and a contacting electrolyte composed substantially of a glycol compound.

4. A potential supplying battery, comprising a cathode formed from aluminum, an anode of lead peroxide, and a contacting electrolyte composed substantially of a glycol compound.

5. A potential supplying battery, comprising a cathod composed of at least one element chosen from the empirical group including aluminum, zinc, magnesium, beryllium and cadmium, an anode chosen from the group of oxides comprising lead peroxide, iron oxide, vanadium pentoxide, cadmium and cuprous oxide, and a contacting electrolyte composed substantially of a compound of the group comprising glycol and glycerol borates.

6. A potential supplying battery, comprising a cathode of aluminum, an anode of lead peroxide, and a contacting electrolyte composed substantially of a compound of the group comprising glycol and glycerol borates.

7. A potential supplying battery comprising a cathode of aluminum, an anode of vanadium pentoxide, and a contacting electrolyte composed substantially of glycol borate.

8. A potential supplying battery comprising a cathode of aluminum, an anode of iron oxide, and a contacting electrolyte composed substantially of glycol borate.

9. A potential supplying battery for voltage operated devices requiring no substantial current, comprising a cathode composed of at least one element chosen from the empirical group including aluminum, zinc, magnesium, beryllium and cadmium, an anode of an electronically conductive material of the group comprising the electronically conductive oxides and carbides, carbon and its conductive compounds, and a contacting electrolyte, chosen from the group of organic compounds comprising ethylene glycol, glycerine, glycol borate and glycerol borate, said cell having no appreciable internal chemical action for the production of current.

10. A battery comprising a cathode, an electrolyte and an anode of an electronically conductive oxide of vanadium.

11. A potential supplying battery cell for voltage operated devices requiring no substantial current, comprising a cathode composed of at least one element chosen from the empirical group including aluminum, zinc, magnesium, beryllium and cadmium, an anode of an electronically conductive material of the group comprising the electronically conductive oxides and carbides, carbon and its conductive compounds, and a contacting electrolyte chosen from the group of organic compounds comprising ethylene glycol, glycerine, glycol borate and glycerol borate, said cell having no appreciable internal chemical action for the production of current, said cell being sealed to prevent leakage of the electrolyte.

12. A potential supplying battery for voltage operated devices requiring no substantial current, comprising a series of sealed cells, each cell composed of a cathode composed of at least one element chosen from the empirical group including aluminum, zinc, magnesium, beryllium and cadmium, an anode of an electronically conductive material of the group comprising the electronically conductive oxides and carbides, carbon and its conductive compounds, and a contacting electrolyte chosen from the group of organic compounds comprising ethylene glycol, glycerine, glycol borate and glycerol borate, said cell having no appreciable internal chemical action for the production of current.

SAMUEL RUBEN.

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DEFENDANT'S EXHIBIT No. 14

Patented Apr. 20, 1937 2,078,143

UNITED STATES PATENT OFFICE

2,078,143

REGENERATIVE ELECTRIC CELL

Lucien Jules Jumau, Paris, France, assignor to Compagnie Generale d'Electricite, Paris, France

No Drawing. Application March 11, 1935, Serial No. 10,480. In Germany March 19, 1934

2 Claims. (Cl. 136—100)

The insoluble salts of lead: the sulphate, phosphate, chloride, bromide, iodide, etc. may be utilized advantageously as depolarizers in electric cells. During discharge of these cells, in fact, there is a reduction of the insoluble lead salt to spongy lead. As the latter has a lower molecular weight than the initial lead salt and its density is greater than the density of this salt, there results, during discharge, progressive increase in porosity. On the other hand, spongy lead being a much better conductor than the lead salts from which it was formed, the conductivity of the positive electrode goes on increasing equally during discharge.

These advantages result in practice in an effective coefficient of the active positive material which is very close to unity. Thus, by discharge, practically all the lead salt can be transformed into spongy lead.

If by suitably selecting the electrolyte, the active material of the positive electrode remains insoluble under all conditions, both at the beginning and at the end of the discharge, since spongy lead is itself also insoluble, a positive electrode very easily recoverable is formed. When the positive material has been reduced to spongy lead by discharge, it is sufficient to oxidize it, which is very easily carried out in the presence of the oxygen of the air, with or without heating. As the spongy lead is transformed into oxide, treatment in the acid of the salt desired (sulphuric, phosphoric, hydro-chloric, hydro-bromic, hydro-iodic acid, and so on) or in a suitable salt of this acid regenerates the initial insoluble lead salt.

The use of a depolarizer of lead sulphate or lead chloride and of a negative zinc electrode is already known. Unfortunately the E. M. F. of these cells is very low since it is only approximately 0.5 volts.

The cells, forming the subject of the present invention, comprise the simultaneous use of a positive electrode with a depolarizer having a base of an insoluble lead salt, of a negative magnesium electrode and a neutral salt solution as electrolyte. Applicant has proved that by using pure magnesium, such as has recently been manufactured, and a suitable electrolyte, the attack of the magnesium in open circuit remains slight.

The combination of magnesium and the depolarizers above mentioned having as a support an unattackable conductor such as lead gives couples the discharge reactions of which are as follows:

$$Mg+PbSO_4=MgSO_4+Pb$$
$$Mg+PbCl_2=MgCl_2+Pb$$
$$Mg+PbBr_2=MgBr_2+Pb$$
$$Mg+PbI_2=MgI_2+Pb$$

the magnesium going into the form of a soluble salt.

These equations show that, during discharge of these cells, the electrolyte does not take part in the reactions. It is, therefore, not necessary to use an acid or basic electrolyte which would attack the magnesium in open circuit. It is sufficient to use as electrolyte a dilute solution of an alkaline or alkaline-earth salt (sulphate, phosphate, chloride, bromide, iodide, etc.) to obtain sufficient conductivity. This electrolyte may be free or held stationary in known manner. Attack of the magnesium in open circuit is thus very slight and can be still further reduced by protecting the magnesium from the action of the oxygen of the air, for example, either by locating the negative magnesium electrode at the lower part of the cell, or by covering the electrolyte with an impermeable substance such as a layer of oil, or again by hermetically sealing the element.

Such cells may also be mounted in such manner that the electrolyte does not come in contact with the electrodes except at the moment of use. For example, there may be used a container with two compartments, one of which is intended for the electrodes and the other for the electrolyte. The passage of the electrolyte into the electrode compartment is effected at the moment of use, either by simply turning over the container, or by any other known method. There are thus obtained cells of remarkable constancy and particularly adapted for use with portable lamps and especially emergency portable lamps capable of being put instantly into operation and giving great power and great energy.

It is to be noted that 0.45 gr. magnesium per ampere hour is sufficient and that the E. M. F. of the cells is in general from 1.2 to 1.3 according to the choice of the depolarizer and of the electrolyte as also of the concentration of the latter.

Having now particularly described and ascer-

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tained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. A regenerative electric cell, comprising a positive electrode including a depolariser consisting of a compound selected from the group consisting of sulphate, chloride, bromide, iodide and phosphate of lead, a magnesium negative electrode, and an electrolyte of a soluble neutral salt, the anion of which is the same as the anion of the depolariser and the cation of which is a metal selected from the group consisting of the alkali and alkaline-earth metals.

2. A regenerative electric cell, comprising a positive electrode including a depolariser consisting of a compound selected from the group consisting of sulphate, chloride, bromide, iodide and phosphate of lead, a magnesium negative electrode suitably protected against air oxygen and open-circuit deterioration, and an electrolyte of a soluble neutral salt, the anion of which is the same as the anion of the depolariser and the cation of which is a metal selected from the group consisting of the alkali and alkaline-earth metals.

LUCIEN JULES JUMAU.

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[fol. 827] IN THE UNITED STATES COURT OF CLAIMS

DEFENDANT'S EXHIBIT No. 15

MANUAL OF CHEMISTRY

A Guide to Lectures and Laboratory Work for Beginners in Chemistry. A Text-Book Specially Adapted for Students of Medicine, Pharmacy, and Dentistry.

By

W. Simon, Ph.D., M.D.,

Professor of Chemistry in the College of Physicians and Surgeons of Baltimore, and in the Baltimore College of Dental Surgery; Emeritus Professor in the Maryland College of Pharmacy, Department of the University of Maryland.

Eighth Edition, Thoroughly Revised.

With Sixty-Six Illustrations, One Colored Spectra Plate, and

Eight Colored Plates, Representing Sixty-Four Chemical Reactions.

Lea Brothers & Co.,
Philadelphia and New York.

[fol. 828]

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[fol. 829] Radium, Ra=223.3. This element, discovered in 1899, has been mentioned in the article on radio-activity, page 73. While radium is closely related to barium it has not been found in the native barium compounds, except when they occur associated with uranium as in pitch-blende, an ore from which uranium compounds are extracted. This ore contains, however, but 0.1 gramme of radium in 1000 kilograms, which is equal to 0.00001 per cent. The residue left, after the uranium has been eliminated, contains from 2 to 3 times as much radium as the original ore. From 1000 kilograms of this residue 10 to 15 kilograms of radiferous barium salt (chloride or bromide) are extracted, and from this the radium salt is prepared by repeated fractional crystallization. The small yield of radium obtained after long and tedious operations make it the most costly material of the day.

Both the chloride and bromide of radium are white, crystalline substances turning grayish in the course of time. Lack of a liberal supply of radium has so far prevented a closer study of its chemical behavior.

Summary of analytical characters of the alkaline earth-metals.

	Magnesium.	*Calcium.*	*Strontium.*	*Barium.*
Potassium dichromate	.....	.....	.....	Yellow precipitate.
Potassium chromate	.....	.....	Yellow precipitate.	Yellow precipitate.
Calcium sulphate	.....	.....	White precipitate forming slowly	White precipitate forming at once.
Ammonium carbonate	White precipitate soluble in NH_4Cl.	White precipitate.	White precipitate.	White precipitate.
Ammonium hydroxide	White precipitate.	.....	.....	.....
Ammonium oxalate	No precipitate unless very concentrated.	White precipitate in dilute solution.	White precipitate in strong solution.	White precipitate in strong solution.
Sodium phosphate	White precipitate.	White precipitate.	White precipitate.	White precipitate.
Flame color	.....	Yellowish-red.	Red.	Yellowish-green.
One part of hydroxide is soluble in	50,000 parts of water.	666 parts of water.	50 parts of water.	28.6 parts of water.
One part of sulphate is soluble in	1.5 parts of water.	400 parts of water.	8000 parts of water.	400,000 parts of water.

Questions—221. Which metals form the group of the alkaline earths, and in what respect do their compounds differ from those of the alkali-metals? 222. How is calcium found in nature? 223. What is burned lime; from what, and by what process is it made, and how does water act on it? 224. What is lime-water; how is it made, and what are its properties? 225. Mention some varieties of calcium carbonate as found in nature, and how is it obtained by an artificial process from the chloride? 226. What is Plaster-of-Paris, and what is gypsum; what are they used for? 227. State composition and mode of

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[fol. 830] IN THE UNITED STATES COURT OF CLAIMS

DEFENDANT'S EXHIBIT No. 16

ESSENTIALS OF GENERAL CHEMISTRY

By
B. Smith Hopkins
Professor of Inorganic Chemistry, Emeritus
and
John C. Bailar, Jr.
Professor of Chemistry, University of Illinois

D. C. Heath and Company
Boston

* * * * * * *

[fol. 831]

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[fol. 832] CHAPTER 27

The Alkaline Earth Metals

The elements of Group II of the Periodic Table have two electrons in their outer shells, and so all of them form ions with a charge of + 2. (Mercury has also a valence of + 1.) The members of the A subgroup are all light, very reactive metals, the reactivity increasing with increasing atomic number. The three members of the B subgroup, on the other hand, are heavy, and their reactivity *decreases* with increasing atomic number.

The "noble gases" of Periodic Group O have all of their shells completely filled, and hence show little tendency to react with other elements. The metals of Group I A (the Alkali Metals) are like these, except that their nuclei contain one additional proton and there is one electron in the outermost orbit. This electron, as we have observed, is only loosely held, and can readily be transferred to another atom. The elements of Group II A have another proton in the nucleus, and another electron in the outer shell. The additional positive charge in the nucleus draws all the electrons in more tightly, so that the atoms of Group II A are smaller, though heavier, than those of Group I A. This means that the metals of Group II A are more compact, denser, and harder than those of Group I A, and have higher melting and boiling points. Since their electrons are attracted more strongly to the nucleus, they are less reactive than the members of family I A. Sodium is soft enough to be cut with a knife, is lighter than water, and melts at 97°. The closely related magnesium cannot readily be cut with a knife, has a density of 1.74, and melts only at red heat. As we progress to the heavier members of the group, the metals become softer and more readily corroded. Because of its scarcity, metallic radium has been studied very little, but we should expect it to be the most reactive, the softest, and the least rigid of the alkaline earths. It is of interest that mercury, which is also a member of Group II, is a liquid and hence the softest of all metals.

All of the members of the family II A react with water—radium and barium vigorously, strontium and calcium quietly, magnesium only with boiling water, and beryllium only with steam at elevated temperatures. The activity

with acids parallels this, but is of course much greater. [fol. 833] Among the alchemists the oxides of calcium, strontium, and barium were called *Alkaline Earths* because these compounds were strongly basic and at the same time resembled alumina, a typical "earth." This name has now been extended to include all of the members of Group II A.

Magnesium (Mg, 24.32)

Magnesium sulfate and chloride are readily soluble in water; consequently they are found in ground waters and give noncarbonate hardness (page 384). Magnesium compounds concentrate in the bittern of brines and much is now recovered from this source. Sea water and salt lakes contain both $MgCl_2$ and $MgSO_4$ and from such solutions salt deposits are made, such as carnallite, $KCl \cdot MgCl_2 \cdot 6\ H_2O$, found at Stassfurt, and the extensive deposits of magnesium sulfate found in Okanogan County, Washington, and Searles Lake, California. The bitter taste of sea water and many mineral waters is due to magnesium ions. Many insoluble magnesium compounds occur in nature, such as the complex silicates, talc or soapstone, serpentine, meerschaum, and asbestos. The carbonates form the most important commercial source of magnesium material. Of these, magnesite, $MgCO_3$, is the most valuable, while dolomite, $MgCO_3 \cdot CaCO_3$, is the most abundant, forming whole mountain ranges. Most limestones contain more or less magnesium carbonate, a fact which is of prime importance in determining the use of the limestone. Large deposits of the mineral brucite, $Mg(OH)_2$, were found in Nevada in 1927. In recent years, a considerable tonnage of magnesium compounds has been recovered from the ocean.

Preparation. Until recently all metallic magnesium was produced electrolytically. Two methods have been used. The American method consists in the electrolysis of fused magnesium chloride to which some sodium chloride is usually added to reduce the melting point of the electrolyte and to increase its conductivity. The magnesium chloride was formerly obtained from the brines of deep wells, but as the demand for the metal has increased the chloride has been extracted from sea water and produced by treating carbonate or hydroxide ores with hydrochloric acid, or by

heating the oxide with carbon in a stream of chlorine. The metal obtained by this method contains about 0.1 per cent of impurities, chiefly silicon, iron, aluminum, and manganese.

In Europe an electrolytic method has been used which resembles the Hall process for the production of aluminum (page 396). Magnesium oxide is dissolved in a fused bath containing the fluorides of magnesium, barium, and sodium. The anodes are graphite and the cathodes are iron

Atomic numbers are given in red. The number of electrons in filled shells is shown in the column at the extreme left; the remaining electrons for each element are shown below the symbol for the element. The structures marked *, and their relationship to chemical properties, are discussed on pages 411 and 412.

	IA	IIA	IIIA	IVA	VA	VIA	VIIA	VIII			IB	IIB	IIIB	IVB	VB	VIB	VIIB	O
1	1 Hydrogen 1																	2 Helium 2
2 2	3 Lithium 1	4 Beryllium 2											5 Boron 3	6 Carbon 4	7 Nitrogen 5	8 Oxygen 6	9 Fluorine 7	10 Neon 8
3 2,8	11 Sodium 1	12 Magnesium 2											13 Aluminum 3	14 Silicon 4	15 Phosphorus 5	16 Sulfur 6	17 Chlorine 7	18 Argon 8
4 2,8	19 Potassium 8,1	20 Calcium 8,2	21 Scandium 9,2*	22 Titanium 10,2	23 Vanadium 11,2	24 Chromium 13,1*	25 Manganese 13,2	26 Iron 14,2	27 Cobalt 15,2	28 Nickel 16,2	29 Copper 18,1*	30 Zinc 18,2	31 Gallium 18,3	32 Germanium 18,4	33 Arsenic 18,5	34 Selenium 18,6	35 Bromine 18,7	36 Krypton 18,8
5 2,8,18	37 Rubidium 8,1	38 Strontium 8,2	39 Yttrium 9,2*	40 Zirconium 10,2	41 Columbium 12,1*	42 Molybdenum 13,1*	43 Masurium 14,1*	44 Ruthenium 15,1*	45 Rhodium 16,1*	46 Palladium 18*	47 Silver 18,1	48 Cadmium 18,2	49 Indium 18,3	50 Tin 18,4	51 Antimony 18,5	52 Tellurium 18,6	53 Iodine 18,7	54 Xenon 18,8
6 2,8,18	55 Cesium 18,8,1	56 Barium 18,8,2	57-71 Rare Earths	72 Hafnium 32,10,2	73 Tantalum 32,11,2	74 Tungsten 32,12,2	75 Rhenium 32,13,2	76 Osmium 32,14,2	77 Iridium 32,17*	78 Platinum 32,17,1*	79 Gold 32,18,1	80 Mercury 32,18,2	81 Thallium 32,18,3	82 Lead 32,18,4	83 Bismuth 32,18,5	84 Polonium 32,18,6	85 Alabamine 32,18,7	86 Radon 32,18,8
7 2,8,18,32	87 Virginium 18,8,1	88 Radium 18,8,2	89 Actinium 18,9,2	90 Thorium 18,10,2	91 Protoactinium 18,11,2	92 Uranium 18,12,2												

Rare Earths	57 Lanthanum 18,9,2	58 Cerium 19,9,2	59 Praseodymium 20,9,2	60 Neodymium 21,9,2	61 Illinium 22,9,2	62 Samarium 23,8,2	63 Europium 24,8,2
64 Gadolinium 25,9,2	65 Terbium 26,9,2	66 Dysprosium 27,9,2	67 Holmium 28,9,2	68 Erbium 29,9,2	69 Thulium 30,9,2	70 Ytterbium 31,9,2	71 Lutecium 32,9,2

	IA	IIA	IIIA	IVA	VA	VIA	VIIA	VIII	IB	IIB	IIIB	IVB	VB	VIB	VIIB	O
1	H															
2																
3											Al	Nonmetallic Elements				
4				Sc	Metals useful in Alloy Steels							Ge	As			Noble Gases
5				Y		Mn								Te		
6				R.E.	Hf	Ta		Platinum Metals	Coinage Metals		Low Melting Metals					
7							Re							Radio Active		

Alkali Metals — Alkaline Earth Metals

NOTE.—*The application for a Patent has become void.*
This print shows the Specification as it became open to public inspection under Section 91 (3) (a) of the Acts.

PATENT SPECIFICATION

Convention Date (Italy): Dec. 9, 1927.

301,923

Application Date (in United Kingdom): Dec. 7, 1928. No. 36,156 / 28.

Complete not Accepted.

COMPLETE SPECIFICATION.

Voltaic Cell.

I, GUIDO FERRABINO, Civil Engineer, of 129, Corso Galileo Ferraris, Turin, Italy, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The present specification concerns a particular mode of composing a Voltaic cell with a constant potential functioning according to a so-called Daniell cycle in which, namely, the constancy and uniformity of the potential is a direct consequence of the substance and of the uniformity of the internal conditions of the functioning element.

The method as here described is founded on the well-known oxidising action of water on metallic magnesium with formation of insoluble oxide and with the escape of nascent hydrogen, which action is fairly energetic in the hot—much slower in the cold process, but is considerably intensified when brought about in a Voltaic cell in which the metallic magnesium functions as anode and the water (suitably rendered conducting through the presence of chemically indifferent salts) as electrolyte. It is of interest to remark at this stage, in connection with the following statements, that the presence of some even neutral and chemically indifferent salts (for instance, sulphate or chloride of magnesium) considerably accelerates the process of the spontaneous oxidation of the magnesium (metallic) in the water.

Hence it follows that by composing a Voltaic cell in which water, made suitably conducting by means of chemically indifferent substances, is used as electrolyte, metallic magnesium as anode and finally, as cathode, an appropriate depolarising oxidising conductor, capable of absorbing the hydrogen generated on the cathode when the circuit is closed, with the renewal of the water decomposed at the anode but without any formation of other soluble and chemically active compounds (for instance, dioxide of manganese, of lead, of barium, metallic hydroxides), there will be realized a Voltaic cell in which, bar the interference of disturbing phenomena of another order, the internal conditions of functioning, and hence the discharge potential, will be kept theoretically constant.

In order that the realization of a Voltaic cell of this description may however be practically carried into effect, it is advisable to provide for the prevention of the spontaneous and rapid deterioration of the magnesium anode, immersed in a saline solution, when the circuit is open. It is therefore expedient to use, as in this particular case, electrolytes wherein such deterioration through oxidation is greatly delayed and altogether prevented when the circuit is open, without however, any prevention, when the circuit is closed, of the chemical reactions which are the source of electric energy. Such properties are enjoyed, to a greater or less degree, (and sometimes even in the presence of salts which, as for instance the chloride of potassium, are not chemically indifferent relatively to the magnesium) by almost all the reducing agents and particularly the soluble sulphites and oxalates which have no direct chemical action upon the metallic magnesium: those which are alcaline being particularly indicated. The action of the reducing agents may to some extent be readily explained, but that does not concern the present exposé. The same marked property is also enjoyed by a few other compounds not possessing any reducing action but having, in all probability, a specific function as negative catalysers. Such are: the ferrocyanides, the soluble chromates and bichromates (particularly those which are alcaline), many soluble chrome salts, the alcaline hydrates.

It will therefore be advisable for the practical reason above-mentioned, to select

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from among these categories of salts those which are suitable for composing the saline solution for the electrolyte, all the more so as they all, by dissociating more or less in water, render the latter a conductor of electricity.

What has been set forth above does not, of course, exclude all those numerous variations open to all experts and which are evidently a direct derivation from the above-expressed principle. Thus, for instance, there is nothing to prevent the composition of the cathode from being modified by the addition of other substances suitable for being reduced by the nascent hydrogen, with formation, not only of water alone, but of other soluble substances capable of acting as auxiliary exciters of the anode, not however to the exclusion of the simultaneous oxidising action of the water on the magnesium when the circuit is closed and the renewal (direct or indirect, total or partial) at the cathode of the water having been decomposed at the anode. This would be the behaviour of the basic sulphate of copper $Cu_3SO_4(OH)_2$, an insoluble salt which acts as if it were constituted by the sum $4CuSO_4 + Cu(OH)_2$, and from which the nascent hydrogen would deposit the metallic copper with formation of sulphuric acid and of water: chlorate of potassium would behave similarly, with formation of potassic chloride and water.

It is further pointed out that the fact of magnesium (metallic) having been cited as a constituent of the anode does not exclude the use of other alloys thereof which are appropriate and behave in a similar manner.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A Voltaic cell in which, advantage being taken of the spontaneous oxidising action of water on metallic magnesium, the latter is used as anode, water (made suitably conducting through the addition of soluble, chemically indifferent salts) as electrolyte and finally, as cathode, a depolarising oxidising conductor, insoluble and indifferent, capable of absorbing the nascent hydrogen with renewal of the water having been decomposed at the anode, without further formation of any substances able to modify the composition of the electrolyte; so that the chemical reactions of oxidation and reduction which occur within the cell are enabled to continue cyclically, the conditions of the system and consequently the discharge potential, being maintained unvaried.

2. A Voltaic cell as above specified, in which, as a particular instance, the electrolyte is composed of an aqueous solution of appropriate salts, chemically indifferent relatively to the magnesium, but possessing the specific property of inhibiting, when the circuit is open, the spontaneous oxidising action of the water on the magnesium, which has been laid down as the basis of the inventive principle concerned, and this either through a manifestly reducing action, or through a probable negative catalytic action, without however preventing, when the circuit is closed, the reactions requisite for the production of the electric energy; which preservative action may also manifest itself in the presence of other salts, not altogether indifferent relatively to the magnesium, that are either pre-existent within the electrolyte or may be formed as a consequence of the use of other auxiliary depolarizers beyond those previously contemplated.

3. A Voltaic cell, the whole as above specified and described.

Dated this 7th day of December, 1928.

(Signed) HASELTINE, LAKE & Co.,
28, Southampton Buildings, London, England, and
19—25, West 44th Street, New York, U.S.A.,
Agents for the Applicant.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1929.

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UNITED STATES PATENT OFFICE.

GUSTAV W. THURNAUER, OF AURORA, AND MILTON M. KOHN, OF CHICAGO, ASSIGNORS TO THEMSELVES, AND SIEGFRIED M. FISCHER, OF CHICAGO, ILLINOIS.

DEPOLARIZER FOR PRIMARY BATTERIES AND METHOD OF MAKING SAME.

SPECIFICATION forming part of Letters Patent No. 552,211, dated December 31, 1895.

Application filed February 20, 1895. Serial No. 539,137. (Specimens.)

To all whom it may concern:

Be it known that we, GUSTAV W. THURNAUER, residing at Aurora, in the county of Kane, and MILTON M. KOHN, residing at Chicago, in the county of Cook, State of Illinois, citizens of the United States, have invented certain new and useful Improvements in Depolarizers for Primary Batteries and Methods of Making the Same, of which the following is a specification.

Heretofore it has been common to make use of copper oxide, either in the form of powder or in the form of a plate, in connection with primary batteries for the purpose of a depolarizer. The use of the depolarizer in the form of powder has, however, been found to be objectionable for many reasons, and therefore the plate form has been adopted to a large extent. In producing such plates it has been found necessary in order to hold the copper oxide in form either to use a bonding material or to bind the copper oxide together by partly fusing it until it assumes a more or less metallic condition. When bonding materials are used the practice has been to use either some organic material—such as asphalt, tar, &c.—or some inert material, such as fire-clay, magnesia, or other equivalent materials.

The above-described methods are very unsatisfactory, for the reason that when the copper oxide is bonded together by the use of organic matter it is necessary that such organic matter be burned out, requiring the heating of the oxide to a very high temperature, and consequently making it much more dense, thereby interfering with the efficiency of the plate. When dead material—such as fire-clay, &c.—is used, it of course remains in the plate, and prevents the complete reduction of the plate, thereby decreasing its efficiency. In cases where the plate is slightly fused, as above stated, the active surface of the plate is necessarily cut down in direct proportion to the extent of the fused surface, and the density of the plate is also increased, both of which are objectionable.

Our invention has for its object to produce a plate which will be free from the objections above stated by providing a depolarizing-plate for batteries which will be much more porous than the plates heretofore used and which will be free from inert material.

To this end our invention consists in a depolarizing-plate for electric batteries consisting of copper oxide and a bonding material which is also a depolarizer, such as chloride of copper, sulphate of copper, nitrate of copper, or other equivalent material.

Our invention also comprises a method of producing such plates.

In the manufacture of our improved plates we take a certain amount of copper oxide, to which we add a certain amount of chloride of copper or equivalent salt, the proportion used being preferably about six parts of copper oxide to one part of the chloride. The proportion may vary greatly, however, depending largely upon the quality of the plate to be produced. We prefer to produce the copper salt by adding to the copper oxide a suitable acid—such as sulphuric, nitric, or hydrochloric—depending upon the salt to be produced; but, of course, the salts may be produced in any other suitable manner. The mixture of the copper oxide and the copper chloride or other salt is then put into a mold and compressed, the pressure varying with the density of the plate to be produced, in some cases pressure as low as eight hundred pounds to the square inch being used, and in other cases as great a pressure as five thousand pounds to the square inch; but we do not desire to limit ourselves to pressure within the limits given, as the pressure may be greatly varied if desired. While the mixture is under pressure it is subjected to a gentle heat, which is not sufficient to fuse the copper oxide. In our practice we have found a temperature of from 150° to 350° Fahrenheit to produce satisfactory results. By thus heating the mixture, and at the same time subjecting it to pressure, a plate is produced which is much more porous than any heretofore used, and which is also free from inert matter, as the copper chloride or other bonding material used acts also as a depolarizer, and increases the efficiency of the plate. The dissolving of the copper chloride by the excitant is also

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THURNAUER'S EXHIBIT No. 17

almost entirely overcome by mixing it with copper oxide, the result being a plate much more efficient than any heretofore produced.

Our improved plate is designed for use in connection with primary batteries in which the excitant is an alkaline or saline solution, but almost any excitant may be used which is not acid in its nature.

We are aware that copper sulphate has heretofore been used in batteries, but in such instances it has been used in a soluble or gelatinous state, and not as a component part of a solid plate, as above described.

It is obvious that our improved plate can be made of any desired form, and we therefore do not limit ourselves to making them in the form of flat plates, or to any other particular form.

That which we claim as our invention, and desire to secure by Letters Patent, is—

1. As a new article of manufacture, a depolarizing plate for batteries consisting of copper oxide, and a bonding material capable of being reduced by gas liberated by the action of the battery, the whole being formed into a solid mass, substantially as described.

2. As a new article of manufacture, a depolarizing plate consisting of copper oxide intermixed with copper chloride, the whole forming a compact solid mass, substantially as described.

3. The method of producing a depolarizing plate which consists in intermixing copper oxide and copper chloride, compressing them, and simultaneously subjecting them to a high temperature which is below the fusing point of the copper oxide, substantially as described.

GUSTAV W. THURNAUER.
MILTON M. KOHN.

Witnesses:
A. J. PFLAMER,
ZACH. HOFHEIMER.

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[fol. 839] IN THE UNITED STATES COURT OF CLAIMS

DEFENDANT'S EXHIBIT No. 19

A.D. 1880, 25th October. No 4341

ELECTRICAL APPARATUS FOR OPERATING BELLS, SIGNALS, AND TELEGRAPHS

Letters Patent to Gregoire Skrivanoff, of Paris, in the Republic of France, Gentleman, for an Invention of "An Improved Electrical Apparatus for Operating Bells, Signals, and Telegraphs."

Provisional Specification left by the said Gregoire Skrivanoff at the Office of the Commissioners of Patents on the 25th October 1880.

Gregoire Skrivanoff, of Paris, in the Republic of France, Gentleman. "An Improved Electrical Apparatus for Operating Bells, Signals, and Telegraphs."

The object of this Invention is to produce a simple and efficient apparatus for operating bells, signals, and telegraphs by electricity. I will describe a small apparatus suitable for houses and other buildings and apartments.

I form an external case of suitable size and shape, say, having somewhat the appearance of the ordinary bell-lever arrangement. The back of this case is fixed or fitted to the wall, and consists of a disc or plate of charcoal, or coal, graphite, or platina.

In the interior of the said case, and upon the said plate I attach with wax or other suitable material a piece of blotting paper, linen, or, still better, of asbestos. A rectangular piece of zinc or zinc amalgam, parallel with the face of the said plate, and maintained at a slight distance therefrom, is fitted to a rod and spiral spring.

When my said improved apparatus is intended to operate at great distances the zinc is replaced by magnesium.

The said rod is soldered to the electro-positive element or material, and passes through the cover of the said case, and is fitted into a small knob of ivory or other suitable material, which knob rests upon the said spiral spring within a circular recess formed in the said cover.

When the said case is secured to the wall I introduce

therein, through an apperture in the upper part of such case, a solution of bichromate of ammonia, strengthened with sulphuric acid or any other suitable liquid in such quantity as not to reach the zinc.

Should magnesium be employed the exciting liquid would then be either a solution of alcoline, chloro-chromate, or a permangate strengthened with sulphuric acid.

Two insulated wires, one of platina, lead from the said back plate and terminate in two small pillars or projections on the upper part of the said case, and form the requisite communication with the bells or signals.

[fol. 840] A.D. 1880.—No. 4341.

Specification in pursuance of the conditions of the Letters Patent filed by the said Gregoire Skrivanoff in the Great Seal Patent Office on the 12th April 1881.

Gregoire Skrivanoff, of Paris, in the Republic of France, Gentleman. "An Improved Electrical Apparatus for Operating Bells, Signals, and Telegraphs."

The object of this Invention is to produce a simple and efficient apparatus for operating bells, signals, and telegraphs by electricity. I will describe a small apparatus suitable for houses and other buildings and apartments.

In order that my said Invention may be more fully understood and be more readily performed I will explain the same, with the aid of the accompanying Drawing, which forms part of this Specification, reference being made thereto by the numerals and letters marked thereon; the same index letter refers to similar parts in each Figure of the said Drawing.

Fig. 1 is a vertical section of my apparatus.

Fig. 2 is a cross-section of the same on the line A, B, Fig. 1.

Fig. 3 is a similar cross-section, without the external cover, showing the apparatus when at rest.

Fig. 4 is a similar cross-section showing the apparatus when in action.

The external cover *b* may be made of ebonite, porcelain, or other suitable material, and may be either plain or ornamental. The back plate or disc *c* is of the best quality of that description of charcoal known as "retort charcoal," homogeneous in structure, compact, fine-grained, yet mod-

erately porous. Agglomerated charcoal may be used, if of the hardest and most sonorous kind. Or the said disc may be of thin plate copper of equal area. This disc *c* is fitted to or within the cover *b*, and secured to the wall in any convenient way.

The inner surface of this disc *c* is partially faced, as shown, with a layer *a* of blotting paper, linen, or by preference, asbestos in silky filaments forming an even and smooth layer thereof. This facing is caused to adhere to the charcoal disc by means of a small quantity of paraffine at the upper part thereof.

Or I use a paste formed by triturating in a large china or other suitable vessel the following ingredients:—

	Parts by weight.
Protrochloride of copper (Cu Cl)	4
Phosphorus, amorphous	2
Phosphoric acid	1.5
Metallic copper, in spangles	2
Total	9.5 parts by weight.

Phosphoric acid being generally moist, only one-eighth part thereof of sulphuric acid need be added to give the paste a sufficient consistency. This paste is applied while hot to the charcoal disc *c* in a homogeneous layer, about 0.1 inch in thickness. I cover the layer thus formed with blotting-paper impregnated with a concentrated solution of chloride of zinc with a few drops of sulphuric acid.

A plate of zinc or zinc amalgam *z* (the electro-positive element or material) is placed parallel with the face of the layer *a*, at a slight distance therefrom, and is soldered to one end of the copper rod *t*; the other end of which rod passes through the spiral spring *d*, and is attached to the knob *e*. This knob *e* rests upon the spring *d* within a circular recess, see Fig. 2.

When the apparatus is required to operate over long distances, or when more electricity is required, I replace the zinc with a plate of magnesium of similar dimensions; the small copper rod *t* being screwed into instead of soldered to the magnesium.

[fol. 841] Near the edge of the disc *c* I form a small circular hole, through which I pass a small split tube of copper, at one end of which tube a long tongue of copper is left; this split tube of copper is kept in place by a small hollow

cylinder of ebonite e^1 or of other suitable material fitted within such tube so as to press the latter against the charcoal by expanding it. The said tongue of copper is passed from the interior to the exterior of the case over the edge of the carbon disc, see Figs. 2, 3, and 4. To the free end of this tongue the negative wire r is attached.

To the copper rod t is attached a strip or tongue of copper t^1, to which is secured the electro-positive wire r, which passes through the said hollow cylinder e^1.

These conducting wires are continued to the bell or other signal to be operated and applied thereto in the usual way for effecting electric action.

The electro-positive metal must be carefully varnished on the surface bearing the conducting appendage.

Before uniting the disc c to the cover b I introduce into the lower part of such case at l as a reserve, a quantity of crystals of chlorochromate of potass, coarsely broken, and moistened by a small quantity of the exciting liquid. These crystals must not touch the zinc.

When the apparatus thus described is put together, as shown in Fig. 2, the lower portion below the metal plate z forms the reservoir for the exciting liquid l which, for zinc, consists of a concentrated solution of chlorochromate of potass strengthened by an eighth part thereof of sulphuric acid; to this is added, when zinc amalgam is used, a trace of chromate of mercury to maintain the amalgamation.

Bichromate of ammonia or other alkaline chlorochromates may be substituted for chlorochromate of potass.

When a plate of magnesium is used instead of the zinc z, I use for the exciting liquid l a very concentrated solution of chromic acid, in which, while cold (about 15° C.), I dissolve chlorochromate or permanganate of potass to saturation.

The first solution, while hot is poured on to the asbestos a, whence it falls into the reservoir.

The liquid l will ascend into the facing a by virtue of capillary attraction.

The apparatus may be fixed to the wall or other place by any suitable and efficient means.

In operating my said improved apparatus, which is shown when at rest in Fig. 3, it is only necessary to press inwards the knob e, which pushes the metal plate z in close and

parallel contact with the moistened facing *a*, as shown in Fig. 4, when an electric current is instantly produced, and the distant signal thereby operated. The electric action is terminated by simply withdrawing the pressure from the knob *e*, when the spiral spring *d* returns the said knob to its normal position as in Fig. 2, and thereby draws away the metal plate *z* from contact with the facing *a*, and thus restores the apparatus to a state of rest.

It is evident that my improved apparatus is of the most simple and inexpensive construction, and entirely supercedes the usual batteries hitherto used for similar purposes.

Having thus fully described and ascertained the nature of my said Invention, and the method of performing the same, I wish it to be understood that I do not restrict myself to the precise details and dimensions now specified by way of illustration, as they admit of considerable variation, according to the distance of the signals to be operated, and to the strength of electro current required, as when applied to railways and the like, without departing from the main characteristics of the Invention, but I claim as new, and desire to secure by the hereinbefore-mentioned in part recited Letters Patent,—

Firstly. The formation of the entire electric pile within the case, box, or button.

Secondly. The composition of the paste and its application as a facing to the charcoal or copper disc.

Thirdly. The composition of the exciting liquid when zinc is used.

Fourthly. The composition of the exciting liquid when magnesium is used.

[fol. 842] Fifthly. The general arrangement of the several parts forming the said electrical apparatus.

Each and all substantially as herein described and shown in the Drawing.

In witness whereof, I, the said Gregoire Skrivanoff, have hereunto set my hand and seal, this Ninth day of April, in the year of our Lord One thousand eight hundred and eighty one.

Gregoire Skrivanoff. (L.S.)

London: Printed by George Edward Eyre and William Spottiswoode, Printers to the Queen's most Excellent Majesty, For Her Majesty's Stationery Office, 1881.

[fol. 843]

[fol. 844] IN THE UNITED STATES COURT OF CLAIMS

DEFENDANT'S EXHIBIT No. 20

No 49 A.D. 1891

Date of Application, 1st Jan., 1891—Accepted, 21st Nov., 1891

Complete Specification

IMPROVEMENTS IN GALVANIC BATTERIES FOR PRODUCING CONSTANT CURRENTS

I, WALTER WENSKY of 225 Friedrich Strasse, Berlin, S.W., Kingdom of Prussia, German Empire, Manufacturer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

Of all the galvanic batteries yielding a constant current used hitherto the Marie-Davy chloride of silver battery is the best; however, owing to its costliness it has not met with general application.

The element hereinafter described, while affording the same convenience as to constancy, is composed of considerably cheaper materials; moreover a larger quantity of ampere-hours is obtained from my new cell. The electromotive force is a little below that of the Daniel cell, but the current produced is of considerably greater strength. The form of my element is that of the voltaic pile, and with but two plates the efficiency of a Daniel cell is attained. As the element remains equally constant during 50 to 60 hours without necessitating a renewal of the materials and needing only about 60 grammes of depolarising salt, it is especially qualified for the production of electric light. As a depolarising agent I employ subchloride of copper, and have found the action of the same to be very energetic. The electrodes of the element are coppr and zinc plates.

The better to make my invention clear, I will proceed to describe a battery made and worked according to my improvements by the aid of the accompanying drawings, in which similar letters denote similar parts throughout the several views, and of which:—

Fig. 1 is a cross-section through a battery of five cells placed one above the other.

Fig. 2 an upper view of Fig. 1, partly in section.

The bottom-plate *c* of the lowest element consists of copper or of another electro-positive material. Hereupon is placed a plate of felt *r*, thereover an osmose-cloth o^1, upon that a filling of powder of zinc *p*, covered with a second osmose-cloth o^2, and on the top a plate of zinc *u*, to which is fastened the plate of copper *c* of the second element, whereupon the other parts follow in the same order as in the first element.

Every cell is surrounded by rubber rings *a* outreaching the edge of the same and keeping the different parts together.

Before the elements are put together, the free space between the lowest copper plate *c* and the lowest rubber ring *a* is filled with subchloride of copper; then I pour in the exciting liquid, a 40 *per cent.* solution of chloride of zinc, to which I add 1 *per cent.* of perchloride of mercury, in order to keep the zinc well amalgamated. The osmose-cloth is also impregnated with the above solution. The diameter of the plate of felt *r* should be smaller than the inner one of the rubber ring *a*. The hollow spaces *z z* are filled with subchloride of copper.

The elements being placed one above the other, two covering-plates *d d* are used to join the same up and to hold them tightly together by means of the screw *s*. The rubber-rings *a* make this battery air-tight and water-tight. This is necessary in order to prevent the access of the humidity of the air to the battery, because the chloride of zinc formed in the latter is very hygroscopic and would cause the liquid of the cells to overflow.

I will now proceed to explain the chemical and electrical action which takes place in the battery.

The electric current decomposes the solution and hydrogen is formed at the negative pole; this hydrogen combines with [fol. 845] the chlorine of the subchloride, thus forming hydrochloric acid and copper, the first almost immediately combining with zinc to chloride of zinc, while metallic copper is precipitated on the copper plate as a porous substance in form of powder; this precipitation begins near the copper plate and gradually extends upwards until the subchloride of copper is completely transformed into

chloride of zinc. Nevertheless, as the first of these salts is not quite insoluble in hydrochloric acid, a quantity of the same might be dissolved, which, when coming into contact with the zinc-plate *u*, would be decomposed and leave a deposit of copper on the latter. This is prevented by the interposition of the osmose-cloth and especially by the layer of powder of zinc, which may also contain oxide of zinc and for which powder of iron may also be substituted. The copper which otherwise would be deposited on the plate of zinc *u* is precipitated on this layer.

The plate of felt *r* has been interposed in order to ensure the contact by filling out cavities, which are formed in the cell by contraction of the exciting liquid, due to the chemical action.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

1. An element for producing constant electric currents, having subchloride of copper as a depolarising agent.

2. An element for producing constant electric currents, having subchloride of copper as a depolarising agent and provided with rubber rings between the single cells, for the purpose as described.

3. An element for producing constant electric currents, having subchloride of copper as a depolarising agent, and provided with rubber rings between the single cells, and with double diaphragms separated from each other by a layer of powder of zinc or iron, for the purpose as described.

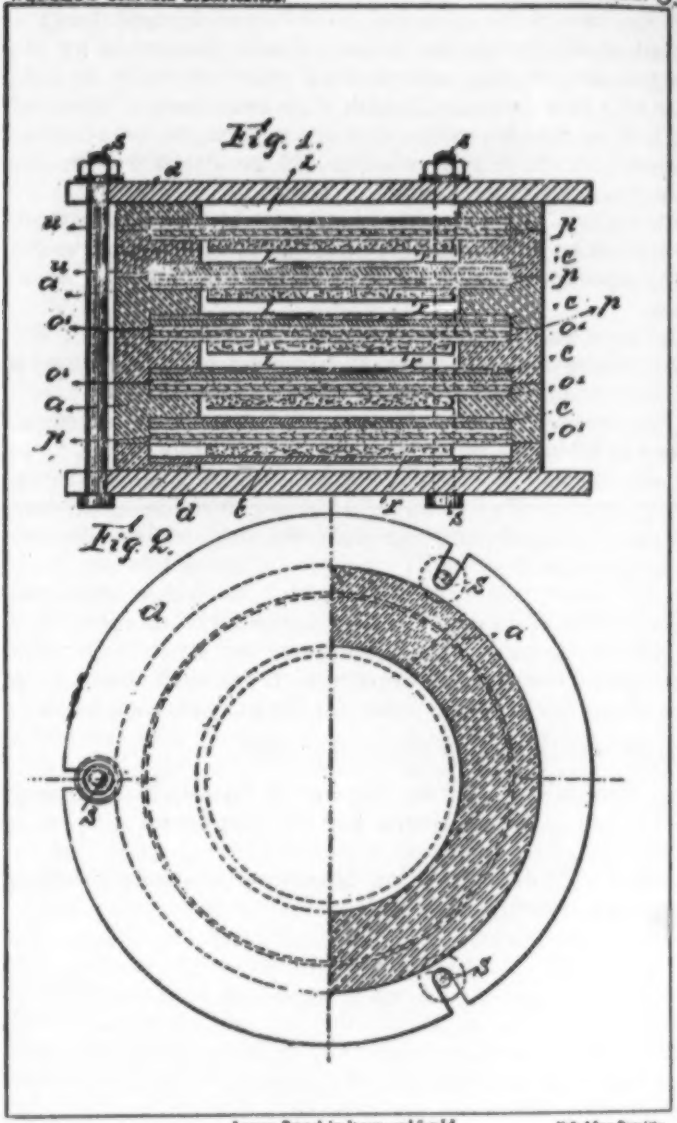
Dated this — day of September 1891.

Walter Wensky, By Rayner & Cassel, 37 Chancery Lane, W.C., Agents for the Applicant.

London: Printed for Her Majesty's Stationery Office, by Darling & Son, Ltd.—1891

A.D. 1891. JAN. 1. N° 49.

WEBSTER'S COMPLETE SPECIFICATION. (1 SHEET.)



[This Drawing is a reproduction of the Original on a reduced scale.]

London: Printed by Darling and Son Ltd.
for Her Majesty's Stationery Office 1891

[fol. 847] IN THE UNITED STATES COURT OF CLAIMS

DEFENDANT'S EXHIBIT No. 21

* * * * * * *

VI.—The Constitution of the Copper-Zinc and Copper-Tin Alloys.

By A. P. Laurie, B.A., B.Sc.

If instead of a simple metal, a mixture of two metals is introduced into a voltaic cell, the E.M.F. of the cell is that of the more positive metal. For instance, a mixture of zinc and copper will give the E.M.F. of zinc.

Several experiments in a cuprous iodide cell with plates of copper having pieces of zinc soldered into them of about 1/2000 of the whole area of the plate, showed this. On first connecting with the electrometer, the deflection was about half that for zinc (the deflection for copper being of course zero), but it gradually crept up, ultimately attaining a value some 4 or 5 hundreths of a volt below the value [fol. 848] for zinc. This gradual increase of E.M.F. was due to some change in the electrical condition of the compound plate, and is probably to be explained by the gradual polarisation of the copper plate by the local action between it and the zinc soldered on to it. But, in whatever way these points are explained, the results are sufficient to show that a mixture of two metals gives the E.M.F. of the more positive metal, and that this holds good as long as at least 0.2 per cent of the positive metal is present.

If, however, in place of a mixture of zinc and copper we have an alloy of the two metals which has been formed with a development of heat, and which therefore is of the nature of a chemical compound, the result will probably be different, for it is obvious that the dissolution of the zinc will in this case necessitate the decomposition of this zinc-copper compound, whereby energy is absorbed, and therefore the E.M.F. of the cell will probably be correspondingly lowered.

Now there are three possible ways in which zinc-copper alloys may be constituted.

First, they may be merely mixtures of zinc and copper; in that case they would give the E.M.F. of zinc in the voltaic cell.

Second, they may be of the nature of the solution of sulphuric acid in water; in that case, a series of such alloys, beginning with 100 per cent. of copper and ending with 100 per cent. of zinc, would probably show a gradual rise of E.M.F. in the cell, from the value for copper to that for zinc.

Third, one or more of the series of alloys may be a definite atomic compound, the rest being solutions of this compound or compounds in an excess of zinc or copper; in that case the E.M.F. would probably rise by a jump when a series of alloys were tested, a slight excess of zinc over that necessary for the compound causing a great alteration of E.M.F. in the cell. Further, this jump would probably occur where the percentages of zinc and copper corresponded with some simple molecular formula.

In practice, the difficulty which presents itself is that of obtaining homogeneous alloys. This difficulty can only be overcome by taking great care in their preparation, and by preparing very large numbers of them. In this way, any error from this cause may be expected to show itself.

My zinc-copper alloys were prepared as follows:—

A certain quantity of copper and of zinc were weighed out, amounting together to about ¾ of an oz., and fused in a Fletcher's furnace under borax; when fused, the alloy was vigorously stirred with an iron rod coated with borax, and poured instantly into a little trough cut in a block of charcoal. The ingot thus formed was cooled, weighed, and then [fol. 849] broken across; if it seemed homogeneous in section the upper layer was filed off, the ingot marked, and laid aside for testing by the electrometer. Some zinc always burned off, and the percentage of zinc and copper was calculated from the weight of copper taken and from the weight of the alloy obtained; this, of course, assumes that there is no loss of copper—in fact it is but very slight, and also necessitates clean casting, which is easily managed if the flux is sufficiently fluid. The stirring was always kept up till the instant before emptying the crucible. The alloys corresponded in appearance to the descriptions already published, the yellow trough "brass" being replaced by white brittle alloys when the copper was diminished below 50 per cent., and these again giving place to hard grey alloys when it was below about 15 per cent.

On testing a piece of brass wire in the cell it gave no deflection, showing a diminution of E.M.F. = 0.6 volt. It

probably contained about 30 per cent. of zinc. One of my alloys containing about 25 per cent. of zinc gave the same result. As 40 per cent of copper was approached, a slight increase of E.M.F. showed itself amounting at 36 per cent. of copper to about 0.1 volt; so that from nothing up to 66 percent. of zinc the E.M.F had gradually risen about 0.1 volt.

The next alloy tested contained about 33 per cent. of copper. It gave a deflection of about 0.5 volt. All the alloys containing less than this amount of copper, though varying a good deal, continued on this higher level of E.M.F. The results are given in detail in Table A (p. 107) and Plate 4 (p. 116).

The want of homogeneity of the alloys is brought out by this table, but at the same time is not sufficient in any way to conceal the striking shape of the curve of E.M.F. showing its sudden rise. It is to be remembered that although the alloys may have an average composition very close to that given in the table, the electrometer will select the portions of the alloy containing an excess of zinc. These experiments indicate, in the first place, a considerable development of heat in the formation of brass, lowering the E.M.F. of the cell about 0.6 volt, and, further, that the greater part of this development of heat is due to the formation of a compound $CuZn_2$ (32.8 per cent. Cu).

After these experiments were completed, I determined to test whether zinc-copper alloys could be separated by differences in their specific gravity.

For this purpose, imitating Matthiessen's experiment, I raised a porous pot, about 3 in. high by ⅝ in. across, to a bright red in a Fletcher's furnace, and poured into it an alloy containing a little over 34 per cent. of copper. The furnace being again closed, and the blast kept on, the alloy was kept fused for at least 30 minutes. It was then allowed to cool, the porous pot broken, and the cylinder of alloy, after it had been filed flat on one side, was connected with the electrometer, and gradually lowered into the cell.

If there had been any regular settling out of alloys according to specific gravity, one end should have had a higher E.M.F. than the other. If, then, the end of lowest E.M.F. was first plunged in the liquid, its gradual immersion would cause an increase of the deflection on the scale. No

[fol. 850] TABLE A.—Zinc copper Alloys.

Percentage of copper.	E.M.F. in volts.
100.0	−0.020
75.0	−0.020
54.4	+0.040
50.5	0.070
49.3	0.070
47.2	0.075
46.1	0.065
43.9	0.070
41.7	0.080
37.0	0.085
36.5	0.085
35.9	0.160
33.8	0.530
33.2	0.520
31.9	0.540
31.9	0.580
30.3	0.570
29.2	0.600
28.0	0.580
26.8	0.490
26.2	0.460
25.7	0.570
24.3	0.475
23.0	0.600
19.1	0.580
18.7	0.420
16.4	0.580
16.2	0.580
14.5	0.590
14.1	0.580
12.4	0.590
12.1	0.600
3.5	0.590
Zinc.	0.600

such effect was produced, however, for no matter which end was first plunged in, the E.M.F. continued at about 0.1 volt, varying slightly. The same alloy, fused up with fresh [fol. 851] zinc to reduce the percentage of copper to about 20 per cent., gave all along its length an E.M.F. of about 0.5 volt, varying slightly. There is therefore no serious want of homogeneity produced by differences of specific gravity. All these experiments tend to confirm the trustworthiness of the results first obtained.

As the slow cooling in an upright position seemed to have no injurious effect, six alloys were made up, of about 2 oz. each, and cast in moulder's earth in an upright position as sticks about 2 in. long and $\frac{5}{8}$ in. in diameter. A portion about 1 in. long was broken from each of these sticks by knocking off the two ends; it was then filed flat on one side and plunged into the cell. The results with these six

sticks are given in Table B. It will be noticed that, with one exception, the deflections increase as the zinc increases with considerable regularity. They are evidently more homogeneous than the first set of alloys.

My next experiment was as follows. Taking alloy No. 6 of the set in Table B, I ground it to powder, and tested its E.M.F. by packing it into a minute glass vessel, shaped like a tobacco pipe, with a platinum wire down the stem and into the bowl, this bowl being plunged beneath the liquid in the cell. It gave an E.M.F. of about 0.5 volt, but as the experiment failed unless the dust was wet and carefully packed, no deflection being obtained, I next filled the bowl with mercury, mixed in some of the dust, and obtained again an E.M.F. of about 0.5 volt. Some of this dust was next treated with dilute sulphuric acid; hydrogen was given off, but after boiling for some time with the acid all effervescence ceased, or almost ceased, although fresh acid was put on. The acid contained some zinc, but no copper. On burnishing the dust, it gave the same bright white lustre as before. The dust when introduced into the bowl of the glass pipe, both with and without mercury, gave the deflection of about 0.08 volt, so that apparently the excess of zinc had been removed by the acid.

TABLE B

Percentage of copper.	E.M.F. in volts.
34.1	0.160
31.5	0.420
31.0	0.560
30.6	0.480
30.1	0.530
29.9	0.570

These results certainly indicate the existence of a compound, $CuZn_2$, the sudden rise of E.M.F. being difficult to interpret in any other way, and seemed to me sufficiently [fol. 852] encouraging. At the same time the zinc-copper alloys, and especially those containing a high percentage of zinc, are difficult of preparation, and very little is known about their physical properties. It seemed better, therefore, to select for further experiments some well-known series of alloys, in order to check the results of this new method against the conclusions of other experimentalists. For this purpose, the tin-copper alloys seemed especially suitable.

In the first place, Riche (*Gompt. rend.*, 55, 1862) states that the curve of densities for these alloys has two maxima, corresponding respectively with the alloys Cu_4Sn and Cu_3Sn. The curve of densities given in Thurston's Report* on the copper-tin alloys, though not showing two maxima, rises to a maximum over the region of these two alloys, falling off towards copper and towards tin. Riche further states that these two alloys alone are not subject to liquation.

Matthiessen (*Phil. Trans.*, 1960) failed to find any indication of the existence of these compounds on testing the electric conductivity of these alloys, but this has been shown by Lodge to be due to his not having investigated that portion of the curve. Lodge (*Phil. Mag.*, 1879) finds a minimum conductivity at CuSn, and a maximum conductivity at Cu_3Sn. Again, the curve for heat conductivity given by Calvert and Johnson (*Phil. Trans.*, 1858), shows a minimum at Cu_4Sn, and maximum at Cu_3Sn. Finally, the induction balance curve as determined by Roberts-Austen (*Phil. Mag.*, 1879), shows the same maximum and minimum. There is consequently a considerable amount of evidence pointing to the existence of the compounds Cu_3Sn and Cu_4Sn in this series of alloys, a mass of evidence first, I believe, collected and pointed out by Roberts-Austen. There alloys, therefore, seemed to be peculiarly suitable for testing the new method. The compound Cu_4Sn I did not expect to find, but the compound Cu_3Sn would in all probability be indicated. In the first place, however, I thought it best to again test the behavior of compound plates, adopting a different arrangement.

A Daniell cell was constructed containing a large cylindrical copper plate, coated with india-rubber on the back, and with a front surface of 500 sq. cm. This plate was placed in a solution of sulphate of zinc. A glass tube plugged with plaster of Paris, and containing a copper wire in a solution of sulphate of copper, formed the other pole of the cell. This wire was connected permanently to the electrometer. A thin strip of zinc, of breadth 5 mm, was arranged so that it could be covered to any depth in

* Report on Copper-Tin Alloys, United States Board, to test iron, steel, &c.: Washington, 1879.

the solution. Either the zinc plate, or the copper plate, or both, could be connected to the electrometer by means of mercury cups. The copper plate was first connected. [fol. 853] It gave a small deflection of about 0.03 volt. The zinc plate was then immersed in the solution to the depth of 5 mm., and then connected by a wire to the copper plate; immediately the spot of light on the scale began to move, and time observations were taken. The results are plotted on Plate 1 (p. 116). The deflection for the zinc alone is also marked on the curve. On disconnecting the zinc plate, the spot of light moved steadily down to the old deflection for copper alone, an appreciable time elapsing before the polarisation of the copper plate ceased. The zinc on removal was found to be corroded, a considerable amount of zinc having been consumed in polarising the copper plate. Similar experiments were made with a cell containing an acid solution of stannous chloride, and a copper wire coated with cuprous chloride for the other pole. In this case also a similar curve was obtained on connecting a tin plate to the copper plate in the same way. In both cases, the surface of the positive metal amounted to about 1/1000 part of the surface of the copper plate. No experiments were made to test the effect of distributing the tin over the copper surface, though I am disposed to think that this would probably increase the rate at which the plate becomes completely polarised. These experiments seem to me to open out an interesting method of investigating polarisation. By weighing the zinc before and after, some light might be thrown on the thickness of the molecular layer necessary to polarise the copper plate, but I did not wait to make any such experiments. If, then, one of our tin-copper alloys contained only 0.1 per cent. of its surface of tin merely mixed with it, we might hope to detect it on the electrometer.

Preparation of the Alloys

The alloys were prepared from the best grain tin and the best copper, 99.9 per cent., obtained from Johnson and Matthey's. A weighed quantity of copper was in each case melted in a plumbago crucible under charcoal, hydrogen bubbled through it to be sure of the absence of suboxide, removed from the furnace, a weighed quantity of tin

rapidly added and thoroughly mixed, and the alloy poured into an open mould. The casting formed a cylinder about 13 cm. long by 0.8 cm. diameter. The aggregate weight of tin and copper was 100 grams. Prof. Roberts-Austen kindly allowed these alloys to be prepared with the assistance of Mr. Groves at the Royal Mint. They had thus the advantage of being made by one skilled in the melting and mixing of metals. They had all a fine appearance on fracture.

The alloys prepared were as follows:—

[fol. 854]

	(1.)	(2.)	(3.)	(4.)	(5.)	(6.)	(7.)	(8.)
Cu per cent....	100	95	90	85	80	75	70	68.18

	(9.)	(10.)	(11.)	(12.)	(13.)	(14.)
Cu per cent....	67	64	61.64	60	40	0

8 and 11 correspond to the two supposed compounds, Cu_3Sn and Cu_4Sn.

Subsequently a fresh set of alloys were prepared of the following percentage composition:—

	(1.)	(2.)	(3.)	(4.)	(5.)	(6.)
Tin per cent....	37	38	39	40	41	42

It was thought advisable to analyse certain of those alloys that were shown to be of especial importance in the ultimate results. These analyses agreed pretty closely with their supposed composition.

Alloy 11 was found to contain 61.7 of copper.

Alloy 12, analysed at both ends, was found to contain 60.4—60.6 per cent. of copper.

Alloy of 39 per cent. in the second series was found to contain 61.2 of copper.

The Cells used

The cells used consisted either of a solution of stannous chloride and a copper wire coated with cuprous chloride, or of stannous sulphate and a copper wire within a porous partition containing copper sulphate. Such tin cells have been carefully tested and found to yield a definite E.M.F. (*Phil. Mag.*, 1886 [5], 21, 13).

Experiments with the Electrometer

I first determined to test all the alloys in succession in a solution of stannous chloride acidified with hydrochloric acid. The composition of the solution was as follows: $SnCl_2$ 33 grams, water 1750 c.c., strong pure hydrochloric acid 17.5 c.c. The cell consisted of a shallow glass dish, with a wooden cover drilled full of holes, through each of which one of the sticks could be dropped, and its E.M.F. tested by the electrometer; in this way, all the alloys were tested under exactly similar conditions. The other pole of the cell consisted of a copper wire coated with cuprous chloride.

The results of the first set of observations in which the rods were polished with emery paper, and then immersed, are shown in Curve (*a*), Plate 2, which gives the mean of this and the next two methods of testing the alloys. The numbers thus given are the mean of two or three independent sets of observations. In the first place, the sudden [fol. 855] rise in E.M.F. on passing Cu_3Sn will be noticed. No corresponding effect is observable on passing Cu_4Sn, but the alloys give slightly irregular deflections in the cell, as shown by the zigzag of the line joining the observations. The irregular numbers are probably due to ephemeral causes, the metals not entering into the action of the cell, and consequently coatings of gas, &c., producing variable deflections, as has been noticed in the case of platinum plates.

Certain precautions are necessary in order to get trustworthy and uniform results in experiments of this kind. In the first place, the cell used should be so designed as to give a definite E.M.F., free from polarisation effects, such as the Daniell, cuprous chloride, or iodine cell. In the second place, the solution in which the alloys are placed should not directly attack the metals in the alloy. In the third place, the salt used should be a salt of the more positive metal. For instance, I have failed to obtain constant results from a cell containing common salt in place of stannous chloride, no doubt due to gas, polarisation of the alloy, complex secondary actions, &c. In the fourth place the alloys must always be carefully cleaned with fresh emery paper before being plunged in the solution. With the electrometer, internal resistance can be ignored, and many arrangements of cells are consequently available.

For instance, I sometimes place the inner solution in a glass tube drawn out to a fine capillary, or sometimes use as my cell a U tube, constricted at the bottom and plugged with plaster of Paris.

With reference to alloy 12, at which the rise occurs, two points are worthy of notice. First the rise is instantaneous, there is no creeping up of E.M.F.., as in the case of the compound plates described before. This is probably due to the distribution of the free tin all over the surface of the alloy instead of being located at one point. The next point is, that in about 10 or 15 minutes the deflection disappeared. This can easily be accounted for by supposing the free tin to exist in pockets and not in veins; these pockets would soon be consumed by the local action, and the E.M.F. would then fall. One confirmation of this is the fact that it is only necessary to reburnish the surface with emery to restore the original E.M.F. Some additional facts favouring this view will be mentioned presently. It is of some interest to note the actual surface of free tin to which the deflection is probably due. If we suppose 1 c. c. of the alloy to be immersed in the solution, then the whole area of the rod present, leaving out the end, amounts to about 2.5 sq. cm. If we suppose the alloy to contain 1 per cent. of tin evenly distributed over the surface, this gives 0.025 sq. cm. as the actual surface of tin in action.

The E.M.F. of the alloys were next tested in a solution of stannous chloride containing no free acid. The results [fol. 856] are given in Curve (*a*), Plate 2. The only difference noticed here was the very gradual disappearance of the deflection of 12, the E.M.F. remaining practically the same for an hour.

The polished surface of the alloys having thus been tested, they were next broken across the centre, and the broken ends plunged in the solution. The results are given in Curve (*a*), Plate 2.

The next experiment was to test the effects of amalgamation. Alloy 11 and 12 were both amalgamated. The E.M.F. were respectively 0.008 volt and 0.26 volt. The only difference caused by amalgamation was that the deflection given by alloy 12 was now permanent. This is of interest, as confirming the view taken of the condition of the free tin on the surface. The mercury doubtless eats into the alloy, and dissolving the tin, brings it to the surface. It will

also tend to check the violence of the local action. It is also curious to note that the alloy 11 is not affected by amalgamation, and that consequently the compound is seemingly unaffected by solution in mercury.

The alloys were next tested in a cell consisting of stannous sulphate in acid solution, and copper sulphate round a copper wire, divided by a porous partition. The results are given in Curve (*b*), Plate 2. They are the mean of two distinct sets of observations. It will be noted that a distinct deflection is given by all the alloys.

Alloys of the second series were now prepared and tested. The results obtained were the same and have not therefore been plotted. The alloys were all amalgamated.

One alloy however behaved differently, namely, 3. This alloy gave uncertain values, sometimes high, sometimes low. If the results of the two groups of alloys are compared together we find that—

1st series, alloy containing 38.3 per cent. tin gives the low deflection 0.008 volt.

2nd series, alloy containing 38.8 per cent. gives an irregular deflection.

1st series, alloy containing 39.5 per cent. gives a definite but vanishing deflection, 0.26 volt.

2nd series, alloy containing 40 per cent. (not analysed) does the same.

2nd series, alloy containing 41 per cent. (not analysed) gives a permanent high deflection.

2nd series, alloy containing 42 per cent. (not analysed) gives a permanent deflection.

It will be noticed how closely their percentage compositions and their behavior on the electrometer agree.

Having completed these measurements, I next searched carefully for Cu_4Sn by two methods. In the first place, [fol. 857] I used a cell in which copper gave a definite E.M.F. as well as tin, so as to get rid of the small irregular deflections noticed in the former cells. For this purpose silver and sulphate of silver were substituted for the copper and sulphate of copper. In this cell, copper gave a deflection of 0.482 volt, and tin of 0.965 volt, consequently a considerable deflection for copper was combined with a marked difference of E.M.F. between copper and tin. There was no indication here of a Cu_4Sn compound, the E.M.F. not rising in two jumps but only one. The second

method was to use a cell in which copper gave a large deflection, but in which the difference between copper and tin was small. Here I hoped that in the region between Cu_4Sn and Cu_3Sn the curve would dip, owing to the necessity of decomposing the mixture of the two compounds. No indications of this have been obtained, as the following figures show:—

Copper, 0.56 volt; alloy 5, 0.55 volt; alloy 10, 0.60 volt; tin, 0.73 volt. The cell used was an iodine cell.

These experiments complete the work with the electrometer. I next experimented on the possibility of eating out the free tin from an alloy by placing it in the cuprous chloride cell and short circuiting. If the electrometer results were trustworthy, an alloy containing an excess of tin over Cu_3Sn would be attacked when used in place of the zinc plate in such a cell, until the excess of tin had been removed. The E.M.F. would then fall practically to zero and all action would stop, Cu_3Sn remaining unaffected. For this purpose, I selected alloy 13 (60 per cent. tin), and cast it into a thin plate about 1 in. x 2 x $\frac{1}{16}$ in. thick. This was placed in acid stannous chloride, and connected with a copper plate in a paste of cuprous chloride inside a porous pot. After two or three days all action seemed to stop, and the plate, under the microscope, in place of having a rough but homogeneous surface, seemed made of bundles of needle-shaped crystals with cavities between. It had not, however, been eaten through, only a thin outer layer having been affected. This outer layer, on being scraped off and analysed, was found to contain 45 per cent. of tin. These results being indefinite, a cell was next constructed in which the finely-powdered alloy could be attacked. Another point attended to was making the cell air-tight, so as to prevent oxidation of the cuprous chloride, and its partial solution, diffusion, and deposition as metallic copper on the alloy. The following diagram (p. 115) shows the cell used.

This consists of a wide-mouthed 1 oz. bottle, containing acid solution of stannous chloride; in this solution, is plunged a copper cup supported by two copper strips. A weighed quantity of the finely-powdered alloy is placed in this cup, and covered with a disc of linen to keep out possible impurities. The bottle is then corked by a glass [fol. 858] tube covered at the end with parchment paper,

and containing a paste of cuprous chloride and a copper plate, the whole being filled up with paraffin; after pushing in the glass tube, paraffin is poured round the neck of the bottle. The powdered sample of alloy taken was found to contain on analysis 36.4 per cent. of tin. The current

from the cell was allowed to flow through a little copper voltameter, the plates of which were occasionally weighed; after 36 hours, the plates no longer increasing in weight, the alloy was removed and analysed; it still contained 44 per cent. of tin, so that this experiment was not very successful. A second supply of alloy was again placed in the cup, and the cell connected to the voltameter. The time curve of the voltameter is given on Plate 3. When the curve had reached the point (*a*) the alloy was removed from the copper cup, re-ground in an agate mortar, and replaced in the cup; immediately the current took a fresh start, as is shown by the curve. When the curve had reached (*b*), the alloy was again removed, ground, and put back; this time very little additional tin was removed, and the alloy was therefore considered fit for analysis. On weighing the residual alloy and calculating the tin lost, the alloy apparently contained 38 per cent. of tin. On analysis, it was found to contain 41.2 per cent. of tin. Evidently, then, this residual alloy agrees pretty closely in composition with the compound Cu_3Sn. The difficulty evidently is to remove the last traces of free tin inclosed in portions of the alloy, [fol. 859] the re-grinding enabling this to be more completely

done. On putting alloy 11 in the copper cup for 36 hours, no change or indication of electric current could be detected.

These experiments, therefore, afford strong evidence that Cu_3Sn is a compound of definite formula and considerable heat of formation, thus confirming the evidence obtained by other methods. It remains to apply the method to less known alloys, with the view of throwing light on their constitution.

* * * * * * *

DEFENDANT'S EXHIBIT No. 22

(No Model.)

C. D. PARKHURST.

GALVANIC BATTERY.

No. 269,454. Patented Dec. 19, 1882.

Fig. 1.

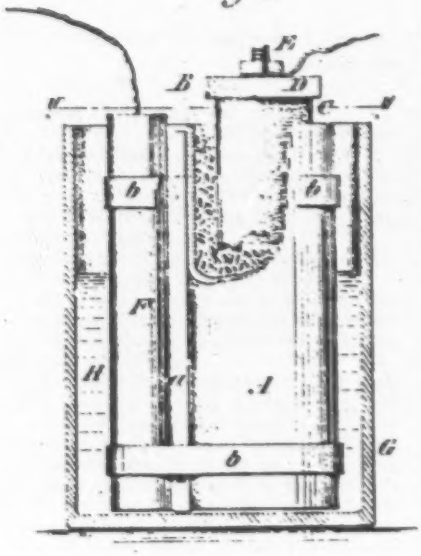


Fig. 3.

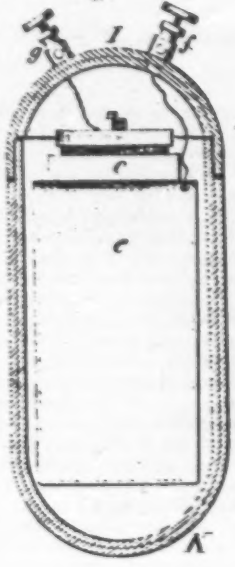


Fig. 5.

Fig. 2.

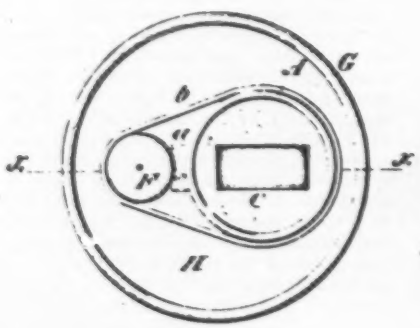
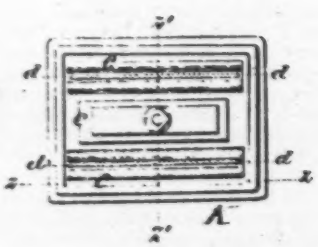


Fig. 4.



WITNESSES:

Joshua Pickwick

E. Bidgwick

INVENTOR:

C. D. Parkhurst

BY Munn & Co

ATTORNEYS.

UNITED STATES PATENT OFFICE.

CHARLES D. PARKHURST, OF PROVIDENCE, RHODE ISLAND, ASSIGNOR OF ONE-HALF TO LEWIS N. FREEMAN, OF ORD, NEBRASKA.

GALVANIC BATTERY.

SPECIFICATION forming part of Letters Patent No. 269,454, dated December 19, 1882.

Application filed May 5, 1882. (No model.)

To all whom it may concern:

Be it known that I, CHARLES DYER PARKHURST, of Providence, in the county of Providence and State of Rhode Island, have invented a new and Improved Galvanic Battery, of which the following is a full, clear, and exact description.

My improvement relates to the class of batteries in which a single fluid is used.

The object of the invention is to effect the rapid and complete depolarization of the negative plate, and thereby increase the efficiency of this class of batteries.

In my improved galvanic battery the positive plate is made of zinc, in any of the well-known shapes, and is provided with a wire conductor connected with it in the ordinary way. The negative plate, which is of carbon, of the kind commonly used in batteries, is placed in a porous cell and surrounded with a mixture of granulated gas-retort carbon, granulated black oxide of manganese, and mild chloride of mercury or calomel, equal parts. These materials are intimately mixed together with a small quantity of water before being placed around the negative plate. As the fluids of this battery, when in operation, are very corrosive, I saturate the upper end of the carbon with paraffine or wax, and make the electrical connection with it by casting lead or solder around it and attaching to it a binding-screw. The porous cell is filled around the carbon to within a short distance of the top of the cell with the mixture of gas-carbon, black oxide of manganese, and chloride of mercury, and the top of the cell is sealed with a cement of resin and wax, or any other insulating-cement insoluble in the fluid of the battery. Two small holes are left in the cement for the admission of water or the exciting-fluid, or for the escape of gas which may be generated in the porous cell.

The porous cell, containing the carbon plate, the granulated carbon, and black oxide of manganese, and the chloride of mercury, as above described, is placed in a suitable jar, together with a zinc rod or plate which has been amalgamated. The exciting-fluid is a saturated solution of ammonium chloride or sal-ammoniac. The shape of the jar is immaterial, although less evaporation of the water would follow from the use of a vessel having a narrow neck, in which the elements are fitted closely, the vessel being provided with a cover. As there are no deleterious fumes given off, this cover is not essential except as a preventer of evaporation and to prevent dust from accumulating in the cell. The character of the porous cell is also immaterial, provided it be of not too hard and impenetrable material. Parchment, cloth, parchment paper, as well as the porous cell as generally used, may be made use of to hold the mass of the depolarizer in its place about the carbon plate; or the use of a porous cup may be entirely avoided by compacting the said mass of the depolarizer into any convenient form and fastening the same to the carbon plate, spaces being left at intervals between the mass and the plate by rubber bands. The zinc may also be fastened against a block of wood or of hard rubber and placed within the same bands, fastening all together in a compact form, thereby diminishing the distance between the two plates, and consequently reducing the internal resistance of the battery.

The action of this battery is as follows: The zinc, calomel, carbon, and manganese being all insoluble in water, there is no internal action when the circuit is open. The circuit being closed, decomposition commences. The zinc is oxidized by the water of the sal-ammoniac solution forming oxide. This zinc oxide immediately reacts with the sal-ammoniac, (ammonium chloride,) first combining with a portion of the chlorine of the latter (and displacing an equivalent of ammonia) and then combining with another portion of the sal-ammoniac, forming ammonia zinc-chloride, while the ammoniac becomes converted into ammonia. The hydrogen, being liberated at the negative plate, unites with its equivalent of oxygen from the peroxide of manganese, reducing this to the sesquioxide, and by this union forming water. The ammonia reduces the calomel into metallic mercury and hydrochloric acid, which latter unites with the ammonia, forming ammonium chloride, to be decomposed, as above described, or this latter acid may act directly upon the zinc, thereby intensifying the action of the battery.

The reaction given above may not be at all times fully complete, and the double chlorides

DEFENDANT'S EXHIBIT No. 23

of zinc and ammonia may be formed, as well as double chlorides of mercury and ammonia; but the above shows the advantage of the use of the calomel, as by its use the ammonia, which previously was a waste product in this class of batteries, is made to play a part in intensifying the action of the battery, and render it practically a constant battery, fitted for any use where a constant current is required, as well as having it still a very desirable and economical form of battery for use with alarms or bells, or other forms of work where open circuit is the rule and closed circuit the exception, as in telephone service. Its small size renders it less cumbersome than many of the forms of battery now in use, while its greater electro-motive force renders it possible to reduce the number of cells and still have a given quantity of current.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which similar letters of reference indicate corresponding parts in all the figures.

Figure 1 is a side elevation, partly in section, on line *x x* in Fig. 2. Fig. 2 is a horizontal section taken on line *y y* in Fig. 1. Fig. 3 is a vertical section, on line *z z* in Fig. 4, of a moist pile form of my improved battery; and Fig. 5 is a vertical section of the same, taken on line *z' z'* in Fig. 4.

In Figs. 1 and 2, A is the porous cell; B, the mixture of gas-retort carbon, black oxide of manganese, and chloride of mercury; C, the carbon plate, surrounded by the same; D, the lead or solder cap, cast on the upper end of the carbon; E, the binding-post. F is a rod of amalgamated zinc, separated from the porous cell by a strip, *a*, of insulating material, and clamped in position by rubber bands *b b*, encircling both zinc and porous cell. G is the battery-jar, containing the exciting-fluid H.

In the dry or moist pile form of the battery shown in Figs. 3, 4, and 5 the porous cell is replaced by a sack, *c*, of canvas or parchment, which is filled with the mixture of carbon, black oxide of manganese, and chloride of mercury, and sealed, as in the case of the battery with a porous cell. The zinc plates *d* in this case are wrapped in blotting-paper *e*, as shown in Fig. 5, and placed upon opposite sides of the sack *c*. The zinc plates are connected by a wire with the binding-post *f*, and the carbon plate is connected by a wire with the binding-post *g*, both binding-posts being secured in the cover I of the case K, which incloses all of the parts of the battery. This case may be made of leather, rubber, or other suitable material.

The exciting-fluid is a saturated solution of chloride of ammonium, which is absorbed by the blotting-paper surrounding the zinc plates, and by the canvas sack and its contents. This battery contains no free solution, and may therefore be carried in the pocket without inconvenience.

I may in some cases employ only granulated carbon with the chloride of mercury as a depolarizer. In other cases I may use only granulated black oxide of manganese in connection with the chloride of mercury, and as an exciting-fluid I may employ chloride of ammonium, chloride of lime, or water simply, or chloride of sodium. Therefore I do not limit or confine my invention to the precise form herein described.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. In a galvanic battery, a depolarizing medium consisting of a mixture of carbon, black oxide of manganese, and chloride of mercury, as herein specified.

2. In a galvanic battery employing a granulated depolarizing agent and a chloride exciting-solution, the combination of chloride of mercury with the granulated depolarizer, as herein specified.

3. In a galvanic battery, the combination, with the closed case K, provided with the binding-posts *f g*, of the canvas sack *c*, containing the carbon plate and the polarizing mixture, and the zinc plates *d*, wrapped in blotting-paper and arranged on opposite sides of the sack, substantially as described, and for the purpose set forth.

CHARLES D. PARKHURST.

Witnesses:
FRANK BOULTER,
W. S. SCHUYLER.

617

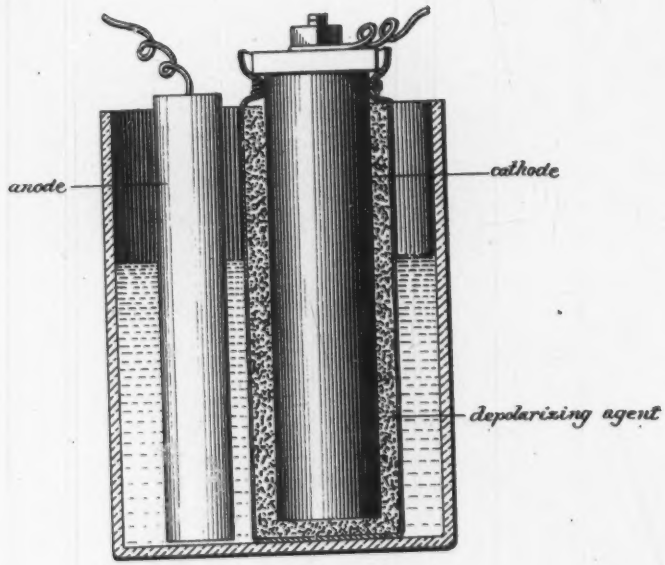
No. 653,770. Patented July 17, 1900.

A. HEIL.

GALVANIC BATTERY.

(Application filed Apr. 9, 1900.)

(No Model.)



Inventor
Albrecht Heil,

Witnesses
J. G. Hinkel
H. M. Gillman, Jr.

By Foster & Freeman,
Attorneys

618

UNITED STATES PATENT OFFICE.

ALBRECHT HEIL, OF FRANKFORT-ON-THE-MAIN, GERMANY, ASSIGNOR TO COLUMBUS, ELECTRICITÄTS-GESELLSCHAFT MIT BESCHRÄNKTER HAFTUNG, OF LUDWIGSHAFEN, GERMANY.

GALVANIC BATTERY.

SPECIFICATION forming part of Letters Patent No. 653,770, dated July 17, 1900.

Application filed April 9, 1900. Serial No. 12,237. (No model.)

To all whom it may concern:

Be it known that I, ALBRECHT HEIL, a subject of the Emperor of Germany, and a resident of Frankfort-on-the-Main, Germany, have invented certain new and useful Improvements in Galvanic Batteries, of which the following is a specification.

The object of this invention is to provide an electric cell or battery of constancy as great as that of Meidinger, from which, however, the improved cell or battery, according to this invention, differs in presenting very slight internal resistance and also in being capable of being used as a "dry" cell or battery. The cell or battery to which this invention relates is of the kind wherein salt of mercury in admixture with carbon is employed as a depolarizing agent.

The use of salt of mercury in electric cells or batteries, owing to the limited conducting power of the said salt, causes the internal resistance of the cell or battery to rise to a very high degree, so as to be unfit for use to yield in a permanent manner currents of any appreciable value, and to overcome this objection it has been proposed to use carbon in admixture with the salt of mercury, and certain electric cells or batteries are known wherein for the purpose of producing more powerful currents a mixture of a salt of mercury and carbon is employed—for example, Beaufils's cell and that of A. Schanschieff, described in the specification of British Letters Patent No. 6,876 of 1884. In these cells the salt used is the protosulfate of mercury, and it is mixed with graphite or plumbago held together with paraffin. A cell so formed on account of the solubility of the protosulfate of mercury and of the high degree of resistance of the electrode due to the use of paraffin will not supply constant currents of any appreciable value.

Parkhurst describes in the specification of a Patent No. 269,454, granted in the United States of America, a cell in which a salt of mercury (chlorid of mercury) is used in combination with carbon and black oxid of manganese. In this cell, however, as in the other cells in which a salt of mercury and carbon have been used, free hydrochloric acid forms and exercises an injurious action and prejudicially affects the durability of the cell. According to this invention chlorid of mercury (calomel) is employed as the salt of mercury, and the carbon may be of any suitable kind, such as finely-divided graphite or plumbago or charcoal. No other material having an electrical effect is employed in this depolarizing mixture; but there is added to it an electrically-indifferent body capable of absorbing or holding hydrochloric acid while current is being derived from the battery, the substance best suited for this purpose being finely-divided chalk, which is thoroughly mixed with the calomel and carbon. In preparing this mixture equal parts, by weight, of the carbon and of the calomel may be used and about five per cent. of the chalk be added.

In practice the cathode may be of carbon and platinum, for example, and it may be placed in a bag tied around the said cathode and filled with the aforesaid mixture, the electrolyte used being preferably a chlorid-of-zinc solution, while zinc serves as an anode.

In the accompanying drawing I have shown in sectional elevation a cell constructed as indicated.

The addition of chalk or the like to the depolarizing material has the effect of destroying the hydrochloric acid forming in the operation of the battery as a result of the reduction of the calomel without injuriously affecting the hydrogen-holding property of the calomel, which is wholly reduced to pure metal down to the stage of exhaustion of the cell, so that the internal resistance of the cell becomes lower rather than higher. Owing to the fact that the reduced calomel remains inclosed in the carbon in the condition of very finely-divided metal the cell may, similarly to an accumulator, be regenerated in a certain degree by means of current supplied from an external source. The cell being capable of being arranged as a dry cell which is durable for practical purposes is an advantage of the highest importance. The electromotive force of this cell is from 1.07 to

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1.10 volts, while its internal resistance is approximately equal to that of the Leclanché cell. At a constant voltage currents sufficient for illumination or for driving small motors can be derived from this cell.

Having now particularly described and ascertained the nature of this invention and in what manner the same is to be performed, I declare that what I claim is—

A cell having an anode, a cathode, and a depolarizing agent consisting of calomel and carbon mixed with an electrically-indifferent body capable of absorbing hydrochloric acid, said mixture surrounding the cathode, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ALBRECHT HEIL.

Witnesses:
FRANZ HASSLACHER,
MICHAEL VOLK.

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[Rolls. 867-868]

DEFENDANT'S EXHIBIT No. 24

Jan. 6, 1925. 1,522,121

J. K. M. HARRISON

POWER GENERATION

Filed Nov. 11, 1919 2 Sheets-Sheet 1

FIG. I

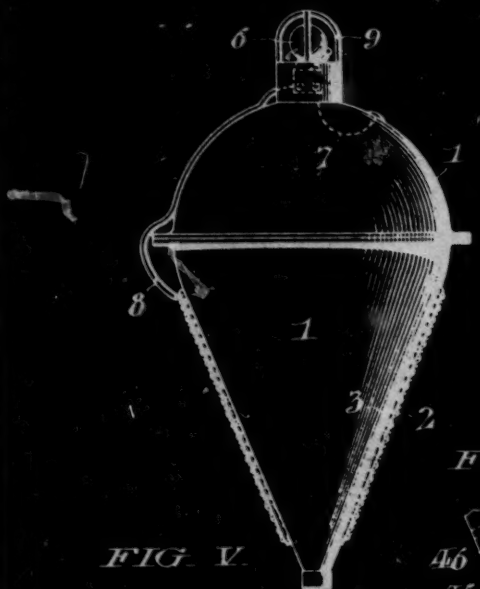


FIG. II

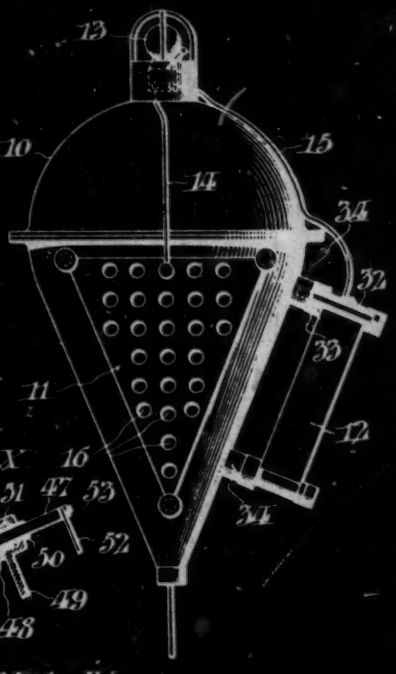


FIG. X

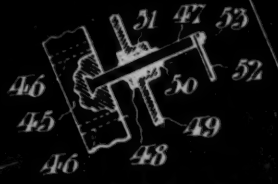


FIG. V.

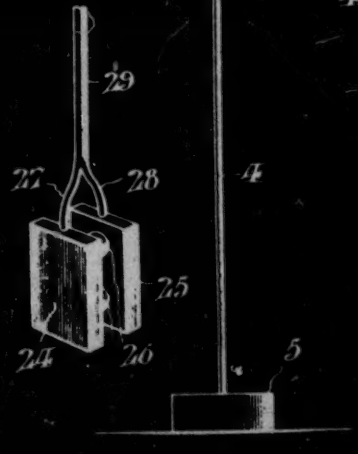


FIG. IV.

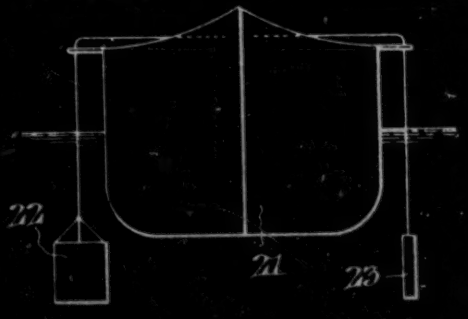
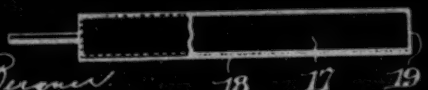


FIG. III.



INVENTOR:
John K M Harrison,
by Fulwey & Paul
ATTORNEYS

WITNESSES:
John C Burgner
James H Bell

621

Jan. 6, 1925. 1,522,121

J. K. M. HARRISON

POWER GENERATION

Filed Nov. 11, 1919 2 Sheets-Sheet 2

FIG. VI.

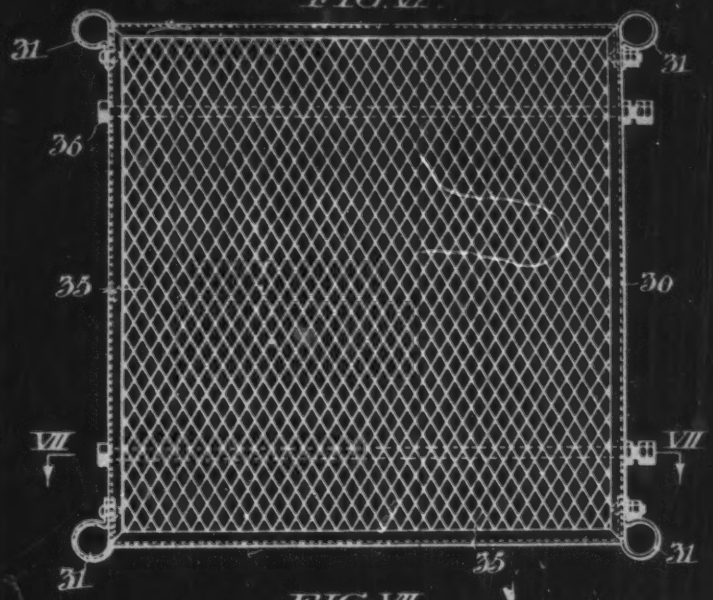


FIG. VII.

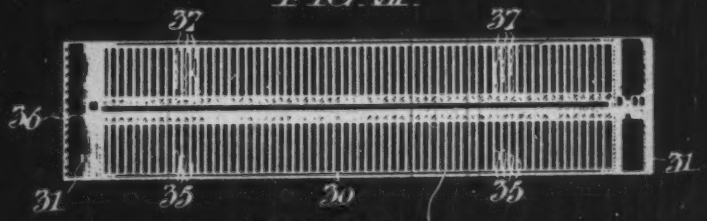
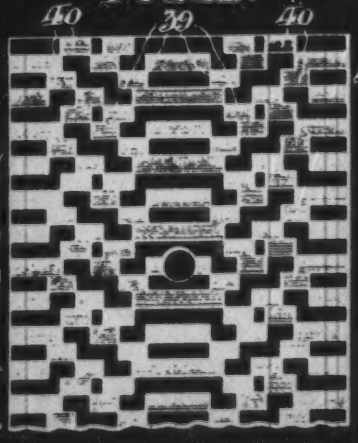


FIG. VIII.



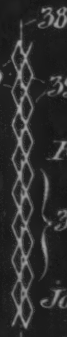


FIG. IX.

INVENTOR:
John K.M. Harrison
by Fulley & Fouy
ATTORNEYS.

WITNESSES
Jos. E. Bryan
James E. Bell.

622

UNITED STATES PATENT OFFICE.

JOHN K. M. HARRISON, OF OGONTZ, PENNSYLVANIA.

POWER GENERATION.

Application filed November 11, 1919. Serial No. 337,219.

To all whom it may concern:

Be it known that I, JOHN K. M. HARRISON, a citizen of the United States, and a resident of Ogontz, in the county of Montgomery and State of Pennsylvania, have invented certain new and useful Improvements in Power Generation, of which the following is a specification, reference being had to the accompanying drawings.

My invention relates to power generation, and its main object is the production of electric power in substantial amount in a novel and advantageous manner. The invention is of special utility in cases where moderate amounts of power are to be used, and in situations where ordinary ways of obtaining it are unavailable or unsatisfactory, or where it is of great importance to have an ever-ready source of such power not subject to derangement or rapid exhaustion, nor to substantial deterioration in periods of disuse. Such situations exist in the case of apparatus for automatic submarine radio, and other danger signals on ships and on buoys remote from shore, and in the case of telegraphic apparatus of ships and their lifeboats, where accidents to ordinary power plant, failure of storage batteries and dry cells seldom used or inaccessible, may result in appalling disaster and loss of life. Other important fields of use for my invention will readily suggest themselves.

Various advantages obtainable in connection with my invention will appear from the following description hereinafter, while its novel features and essentials will be indicated in my claims.

I have discovered that electric power and energy in substantial amount can be obtained by means of what I term a "sea-battery" depending on the galvanic couple formed by dissimilar elements or electrodes immersed or exposed in the sea water as electrolyte over sufficiently extended areas. The electrodes being immersed directly in the sea itself, the supply of electrolyte is readily maintained and incapable of exhaustion or deterioration. Hence the voltage and current output can be much more constant over long periods of use than in the case of ordinary galvanic cells, and the life of the battery is limited only by consumption, wastage, or disintegration of the electrodes, especially the cathode. I have referred to the sea and to sea-water; but it will be apparent that the utility of my sea-battery device extends to other bodies of water.

I am aware that it has heretofore been proposed or even attempted to obtain energy from the sea in a great variety of ways; but so far as I know, such proposals have generally been of an extravagant and visionary character, they are inoperative or impracticable, for one reason or another, and have in no case led to any practical outcome beyond the obtaining of a few milliamperes of current at a voltage not exceeding a fraction of hundredths of a volt, and only for highly specialized purposes where the very small demand for current was qualitative merely. By means of a sea-battery constructed in accordance with my invention, I have obtained currents of several amperes and voltages of several volts, at will, and this without making the apparatus of any very considerable size.

As regards the relation between power output and area of exposure of electrodes to electrolyte, the "spread" of the metal surface in reference to the electrolyte seems to be a factor, as well as the area of metal surface in contact with the electrolyte.

That the current and power obtainable should vary with the area of the metal surface in contact with the electrolyte is only what might be expected, since it obviously affects the internal resistance of the battery. The influence of spread, or the area of exposure of the metal surface on current and power output seems to be likewise due to the effect of spread on the internal resistance of the battery, the increased spread of the metal surface [illegible] the effective internal mixing "tube" of electrolyte (to the exclusion of sea-water from the area of hydrostatic flow at its end or base) at the electrode. This considerably [illegible] the greater degree to the anode [illegible]. Furthermore, I have found that the metal surface be sufficiently large [illegible] to provide for [illegible] made to accumulate, the effect of [illegible] slight as to be of little

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practical consequence. The internal resistance of the battery being the decisive factor, it is found that the capacity cannot as a practical matter be increased indefinitely by enlarging the electrodes.

Since polarization takes place on the positive pole element or anode, the anode must normally have relatively large exposed area in comparison with what is required for the negative pole element or cathode. While the ratio may vary greatly with different materials and conditions, 10:1 to 5:1 is suitable under ordinary conditions. To a certain extent, however, the necessity for very large anode surface may be offset by so arranging the anode as to take full advantage of the waves as a means of depolarization, or of any other ordinary relative movement of water and anode, such as that arising from the motion of a ship, a buoy, or the like. It will be understood that polarization, being due to chemical decomposition of the electrolyte, increases with electrode spread, but does not increase so rapidly with contact area when spread remains unchanged.

When the battery device is used in connection with a floating structure,—such as a ship, buoy or the like,—this structure itself can often be functionally incorporated in the battery. In this case, it will usually be of advantage to have an exterior or outermost wetted metallic surface of this structure serve as anode, since this affords the advantages of large "spread" and effective depolarization by movement in reference to the water. If this wetted surface of the floating structure be very large,—as in the case of the skin of an iron or steel ship, or of a wooden ship copper sheathed as a protection against fouling or parasite attack,—the effect of polarization will be virtually nil. Generally speaking, however, there is no objection to making the skin or other portion of a floating structure the cathode, because in such a case the electrolytic loss of material will usually be infinitesimal in comparison with the large area of action.

As regards the materials of the exposed electrode surfaces, not only must they be so located in the scale of galvanic potential characteristics as to form a couple of sufficient potential difference; but they must fulfill other requirements arising out of the peculiar conditions of service. Some metals that might otherwise seem available and highly desirable are subject to rapid destruction or wastage in sea-water, even when not in closed circuit; others tend to coat themselves with compounds whose insulating or other properties lower their potential characteristics very seriously. The very expensive metals,—such as gold and platinum, etc.,—are naturally out of the question except in very thin coatings that would be too liable to accidental puncture with consequent destruction of the parts by local electrolytic action, so that their use is excluded in ordinary conditions of service. This factor of local electrolytic action is of great practical importance; it necessitates making all surfaces exposed to the sea-water that are in electrical connection of materials with the same potential characteristics,—which means, practically, making them of the same material. For conditions where accessory parts (such as current leads, for example) cannot be imperviously protected against contact with the sea-water, this factor eliminates from consideration many materials desirable for electrodes simply because they have not the mechanical properties necessary in the accessory parts, or lose these properties under exposure to sea-water. In cases where current leads are of different material from their corresponding electrodes, they must be kept from exposure up to and including their very junctions with the electrodes, as well as for the rest of their length.

The electrode materials which I have found to answer varying requirements to the best advantage are magnesium, zinc, iron and steel, copper, molybdenum, tungsten, and carbon, here ranged in the reverse order of magnitude of their galvanic potential characteristics in sea water as electrolyte, so that each is electropositive with reference to all following it, and vice versa. Magnesium is subject to such wastage in sea-water (a point already referred to) as ordinarily forbids its use without special precautions such as will be indicated hereinafter. Zinc, indeed, tends (under certain conditions, at least) to coat itself with compounds that lower its potential characteristic somewhat, as mentioned above; but even with its deteriorated potential characteristic, it still holds its place on the negative side of iron and steel, and it does not seem to form such a coating so long as current is actually being taken from the battery. Its ease of application as an impervious coating on iron and steel combined with the anti-corrosive protection it affords them give it a peculiar value where long immersion and great power on one single brief occasion of use are the desiderata. Iron and steel are useful on account of their cheapness and mechanical properties, and hence most valuable where very extended area of exposure combined with moderate voltage are desired and satisfactory; their presence in the hulls of ships and other marine structures also gives them special importance.

Not only has copper well-known useful mechanical and electrical properties, (which make is especially desirable for current

an advantage whatever for use. I know of no unique as it is unexpected in view of its known properties, with exposure to sea water, its potential characteristic and current yield for a given area gradually improve some one. Whether this is due to a greenish slime (probably a base chlorate with some sulphate) that seems to form on the metal, or to other causes, I cannot say, but my observation leaves no doubt as to the fact.

Carbon is valuable for its cheapness as well as for its high potential characteristic, and it has the advantage of being easily produced with a naturally cellular or porous structure, which gives it great virtual exposed surface. The fineness of its foraminous interstices has, however, a disadvantage in the difficulty and slowness with which, being made, it depolarizes after current flow has been stopped by opening of the battery circuit; this seems to be due to capillary trapping of the polarizing gas in its pores. Its best field of use, therefore, is in cases where intermittent current flow is desired, so that short periods of activity alternate with relatively long intervals of rest. Movement of the sea water seems to have no depolarizing effect upon it.

Tungsten and molybdenum are valuable for their very high potential characteristics—an advantage which in many cases may be offset by their relatively high cost. The potential characteristic of tungsten in particular, is phenomenally high in comparison with other non-precious commercial metals; and when it is used in sea water, the rapid deterioration which it suffers in ordinary water (in consequence of absorbed or occluded oxygen) does not occur.

In the drawings, Fig. I, is a somewhat diagrammatic view illustrating a sea battery in accordance with my invention applied to a channel marking buoy.

Fig. II, shows another channel marking buoy organization.

Fig. III, shows an arrangement for the use of cathode depolarizing metal in an electrode.

Fig. IV, shows a sea battery combination in which the hull of a steel ship may be utilized as one electrode.

Fig. V, shows still another form of battery device.

Fig. VI, is an enlarged front view of an electrode or pole element cover shown in Fig. II, somewhat diagrammatic.

Fig. VII, shows a section of the device of Figs. II and VI, at a plane corresponding to the line VII—VII in Fig. VI.

Fig. VIII, is a greatly enlarged fragmen

Fig. IX, is a corresponding edge view of a pole element.

Fig. X, is a fragmentary detail view illustrating a modified construction for a pole element.

The battery organization shown in Fig. I comprises a floating channel marking buoy 1, suitably supported in the water by an explosive charge 2, which the external metallic shell of the buoy 1 comprises a netting of wire such as gauge 8 or 9 suitably stretched and secured over the skeleton framework of the buoy, as by a series of interposed lashings or coverings 4, which may be made of canvas, duck or of more open mesh material permeable to the sea water. The buoy 1 may be of the ordinary type and design and may be provided with a skin or shell of sheet metal and may be secured to a suitable anchor 5 by an anchor rope or cable 6 connected to the buoy so that the latter normally floats in an upright position with its upper end above the water line. A low voltage electric battery is formed between the buoy 1 as electrodes by means of the metal netting 3 and the latter normally floats in and is moved by the water and preferably has its ends 7 and 8 connected together by means of a conductor 9 which may be insulated and may surround the buoy 1.

It will be seen that both of the electrodes 1 and 2, are freely exposed to be wetted and washed by the seawater. If buoy 1, as the anode is of steel, as usual, and the wire netting 2 of copper, the latter will form an anode of large, coiled, fine mesh spread, arranged in the most advantageous manner possible for taking advantage of depolarization by the waves. The exposed steel cathode surface including buoy 1, cable 4, and a chain 5, will also be supplied, and the loss by electrolytic action will be correspondingly reduced over the buoy. Moreover, the amount of copper required is relatively small.

In Fig. II, the channel buoy 10 carries a separate battery container 11 in which are inserted the electrode 12 and 13, preferably mounted through the electrode 12 is connected to a wire or cable 14 which is connected to the buoy 10 and thus to the electrode 13. The electrode 12 is in the form of a heavy tungsten or other plate mounted, if preferred, on a frame of one or more bars 15 and 16 of steel, iron or the like, which are connected to the buoy 10 by a cable 17. The electrode 13 is preferably in the form of a cylinder of copper wire netting, which is supported within the battery container 11 by a suitable frame 18 of steel, iron or the like, which is connected to the buoy 10 by a cable 19. The electrode 13 is preferably in the form of a cylinder of copper wire netting, which is supported within the battery container 11 by a suitable frame 18 of steel, iron or the like, which is connected to the buoy 10 by a cable 19. The electrode 13 is preferably in the form of a cylinder of copper wire netting, which is supported within the battery container 11 by a suitable frame 18 of steel, iron or the like, which is connected to the buoy 10 by a cable 19.

625

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posed surface. The anode 12, may be of copper; as preferred mode of construction is described hereinafter.

Fig. III, shows a bar 13, of magnesium or other metal subject to rapid disintegration in water with an impervious coat 14, of marine glue or other insulating material insoluble in water. As shown, the coating 14 leaves the end 19, of the bar exposed, which affords sufficient surface for its action as cathode while preventing the general disintegration over a much larger surface than would otherwise occur. As the bar 13, wastes away at its end, the thin skin of marine glue 18, is left unsupported and crumbles away. Such a magnesium bar may be some 6" to 8" in diameter, for example.

Fig. IV, illustrates diagrammatically the use of the outermost surface of a steel ship 21, as one electrode in conjunction with one or another of two electrodes 22 and 23. If the ship be made cathode, the anode 22, may be of copper and may be constructed like the anode 12, of Fig. II, and it may be arranged as shown so that the water can pass directly through it as the ship moves, so as to give maximum depolarizing action. Or, if very great power capacity is desired, the anode 22, may be a slab of ordinary battery carbon with holes therein to increase the surface in contact with the sea-water.

If the ship is to be anode, the cathode 23, may be of magnesium protected as above set forth; or if maximum power for a very short time only be demanded, it may be a bare magnesium slab 2"x12"x2", for example, with a number of ½" holes.

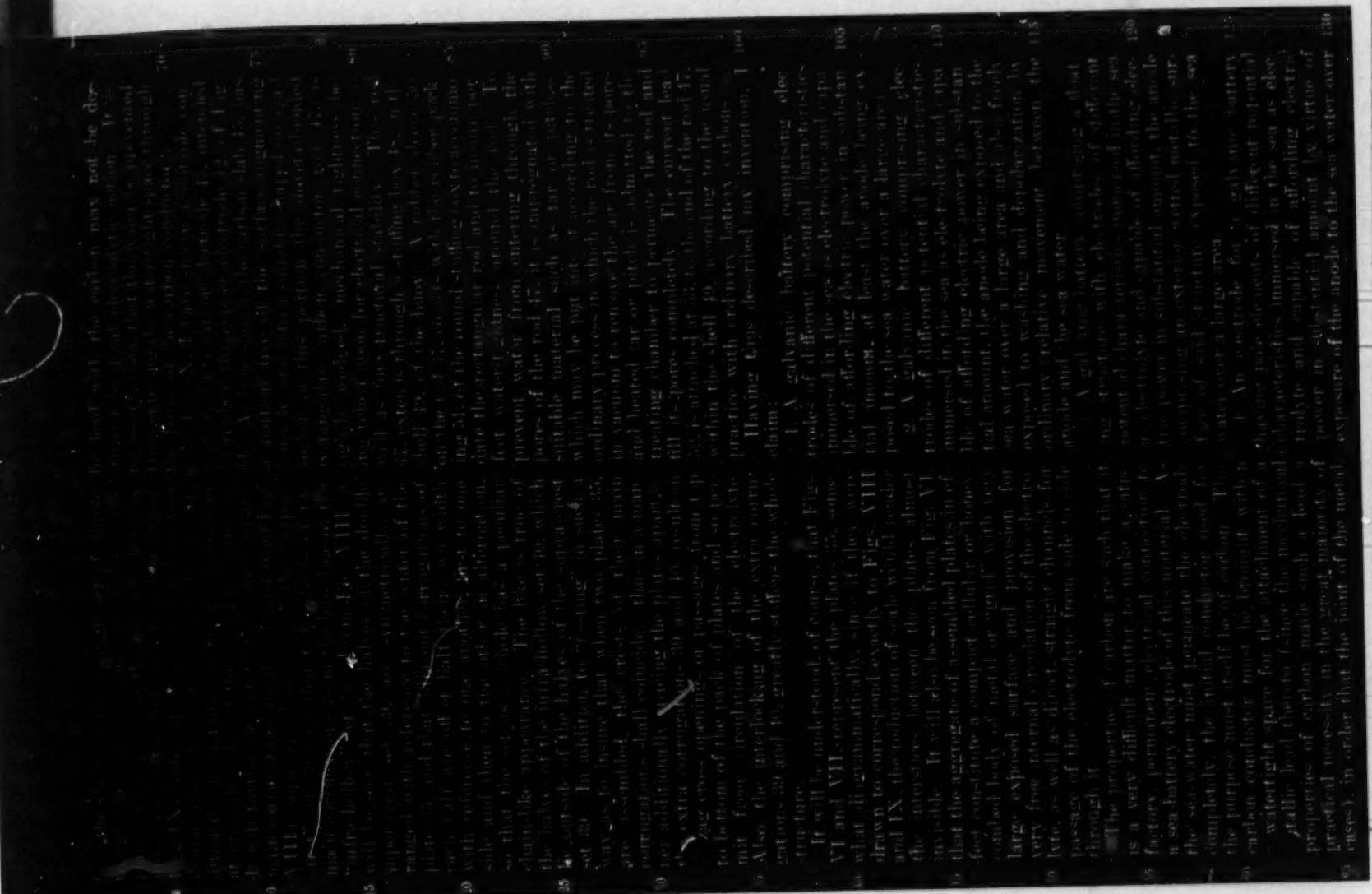
Of course the electrodes 22 and 23, may be used together to form the battery to the exclusion of the ship's hull.

Fig. V, shows a compact, convenient battery device intended to be thrown overboard for occasional or emergency use; it consists of a pair of thin rectangular electrodes 24, 25, insulatively secured together by struts 26, and provided with current leads 27, 28, which are united and insulated to form a single towing and conductor cable 29. The flat faces of these electrodes being parallel to one another and to the direction of travel through the water, good depolarization is obtained.

The electrode 12, shown in Fig. II, comprises a relatively small amount of metal with a large area of active contact surface condensed into small space in a compact, handy form, large area of contact surface being relied on for the desired current capacity rather than maximum spread. As here shown, the large area is obtained by giving the metal a foraminous or cellular structure. When the device is arranged as shown, the water of the sea passes directly through it, so that good depolarizing action is obtained. With such an electrode device of copper having 10,000 square inches of exposed surface, and a zinc anode 11, the maximum current can easily be maintained at about 50 amperes, the current falling off when the temperature of the sea-water is about 62° F.

In order to give the pole element 12, such foraminous or cellular structure, it may be built up in a particular way that I have invented and have illustrated in Figs. VI to IX. As will be seen from Fig. VI, the pole element 12, has, in this construction, a frame structure 30, (about 12" square) formed of sheet metal strips with inturned edges (see Fig. VI) bolted together at their corners, the ends of opposite strips being curled back on themselves to form tubular sockets 31, adapted (see Fig. II) to fit over the flanged insulating sleeves 32, (of bakelite or the like) which co-act with insulating washers 33, (or similar material) to insulate the pole element from the standards 34, attached to the buoy 10. In this frame structure 30, is a pack of superposed thin metal plates 35, tightly spaced apart (see Figs. VII, and IX) in place by bolt rods 36, extending through them from side to side of the frame, and also by engagement of their ends in the shallow channels formed by the inturned edges of the frame side plates. By making these plates 35, of say 6" sheet copper corrugated to space them apart and increase the interstitial surface, 10000 square inches or more can easily be obtained with plates only 3" wide forming a pack about 13" thick. Washers 37, are preferably interposed between the plates to improve their electrical connection to the bolt-rods 36, to one of which the current lead 15, is attached (see Fig. II).

While various modes of corrugation will answer the purpose more or less adequately, I prefer to employ such a one as is shown in Figs. VIII and IX. In Fig. VIII, all the short longitudinal lines between light and shaded areas (whether heavy shade lines or not) represent shearing of the metal, and all the transverse lines separating light and shaded areas represent bends in the metal. By a suitable die, the metal may be bent about 22 out of its original plane both up and down at the same time of sheering (being, perhaps, also stretched somewhat) along lines extending transversely of the strip as noted above, and lying both at the ends of the shear lines and at the middle of each such lines. This is done in such a way that all the light areas lie in the same of parallel planes inclined upward toward the lower edge of the drawing, and all the shaded areas lie in the same or parallel planes inclined downward toward the lower edge of the drawing. The result is (as will be seen from comparison of Figs. VIII and IX)



a large area, said electrode comprising a body of foraminous metal interstitially exposed to the water.

5. An electrode for a galvanic battery having pole elements of different potential characteristics immersed in the sea as electrolyte and capable of affording electric power in substantial amount by virtue of exposure of the anode to the sea water over a large area, said electrode having a large exposed metallic surface condensed into a small compact space.

6. An electrode for a galvanic battery having pole elements of different potential characteristics immersed in the sea as electrolyte and capable of affording electric power in substantial amount by virtue of exposure of the anode to the sea water over a large area, said electrode consisting of metallic copper.

7. An electrode for a galvanic battery having pole elements of different potential characteristics immersed in the sea as electrolyte and capable of affording electric power in substantial amount by virtue of exposure of the anode to the sea water over a large area, said electrode comprising a body of foraminous copper interstitially exposed to the water and having the property of improving its potential characteristic with exposure to sea water.

8. An electrode for a galvanic battery having pole elements of different potential characteristics immersed in the sea as electrolyte and capable of affording electric power in substantial amount by virtue of exposure of the anode to the sea water over a large area, said electrode comprising a compact cellular metallic grid, with large exposed surface condensed into small compact space.

9. An electrode for a galvanic battery having pole elements of different potential characteristics immersed in the sea as electrolyte and capable of affording electric power in substantial amount by virtue of exposure of the anode to the sea water over a large area, said electrode comprising a pack of superposed thin metal plates slightly spaced apart and having large exposed surface condensed into small compact space.

10. An electrode for a galvanic battery having pole elements of different potential characteristics immersed in the sea as electrolyte and capable of affording electric power in substantial amount by virtue of exposure of the anode to the sea water over a large area, said electrode comprising a pack of superposed, corrugated thin metal plates slightly spaced apart by their corrugations and having large exposed surface condensed into small compact space.

11. A current connection for a carbon sea-battery electrode comprising a carbon conductor secured to the carbon electrode by a carbon wedge connection and extending within a watertight space, said rod being suitably impregnated to prevent entry of water into such space through its pores.

In testimony whereof I have hereunto signed my name at Philadelphia, Pennsylvania, this fifth day of March, 1919.

JOHN K. M. HARRISON.

Witnesses:
JAMES H. BELL.
WILLIAM W. AMMEN.

[fols. 877-878] IN THE UNITED STATES COURT OF CLAIMS

No. 163-60

BERT N. ADAMS et al., Plaintiffs,

vs.

THE UNITED STATES, Defendant

Before the Honorable Commissioner, Donald E. Lane

PLAINTIFFS' REQUESTED FINDINGS OF FACT AND CONCLUSIONS OF LAW—Filed October 11, 1961

Now come the plaintiffs, by their attorney, and request the Commissioner to find that the facts set forth herein were proven at Final Hearing and are deemed material to the full and proper presentation of this case and that they be included together with Plaintiffs' Brief and Exhibits in his report to the Court.

The Findings of Fact, as set forth herein, are extracted in part from Plaintiffs' Brief filed simultaneously herewith. The numbers appearing in the brackets following each of the numbered Findings refer to the pages in Plaintiffs' Brief on which the information relating to the finding appears.

Respectfully submitted, John A. Reilly, Attorney for Plaintiffs, 165 Broadway, New York 6, N.Y.

Of Counsel: Kenyon & Kenyon, Richard A. Huettner, New York, N. Y.

October 12, 1961

* * * * * * *

[fol. 879] 6. Silver Chloride Is The Equivalent Of Cuprous Chloride In The Adams Battery System And Defendant's Silver Chloride Batteries Infringe

116. [Br. pp. 104-5] Defendant, in attempting to anticipate plaintiffs' patent, cited 21 references as anticipatory; of these 11, or more than half, contain disclosures of bat-

teries in which the cathode is made of *silver chloride* unified either by liquefaction by heat or liquefaction by water or in which the silver chloride is unified by pressure (DX-1-11). Nine of these references date between 1880 and 1894. The [fol. 880] silver chloride art cited by the defendant is an admission of the equivalency of silver chloride and cuprous chloride when silver chloride is employed in the Adams battery system in combination with magnesium and water.

117. [Br. p. 105] One reference cited by defendant appears to be dispositive of the issue by itself, the British patent No. 49 to Wensky of 1891 (DX-20) in its second and third paragraphs, on page 1 thereof, teaches the interchangeability of cuprous chloride and silver chloride in the Marie Davy type of battery. Although this is a different battery system (R-186), the equivalency of the two materials in the art is clear.

118. [Br. pp. 105-6] Published statements by defendant and defendant's contractors, made long prior to the commencement of this suit, show that the electrochemical equivalency of cuprous chloride and silver chloride in the Adams system is recognized.

In an article in the Tenth Annual Battery Research & Development Conference by E. M. Morse of Eagle-Picher it is stated that:

> "The most widely used water activated systems are silver chloride/magnesium and cuprous chloride/magnesium. . . ." (CX-2, p. 23)

In the same report, Mr. Morse further said:

> "Almost all of the batteries shown in the slides have been constructed using the cuprous chloride/magnesium system. *There is no doubt that each of the units could have been built with silver chloride elements,* but economic considerations prevented their use. . . ." (CX-2, p. 25) (Emphasis ours)

Mr. Pucher of Willard Storage Battery, a subsidiary of Electric Storage Company, a contractor of defendant (see TX-1), stated in the *Journal of the Electrochemical Society* for August, 1952 as follows:

> [fol. 881] "Cuprous chloride-magnesium batteries are characterized by good current and power-output, al-

most constant potential, long shelf life, and are capable of being discharged in temperatures as low as —50°C after being activated at room temperature. They have a considerable cost advantage over the silver chloride-magnesium cells which *have similar characteristics.* However, the cuprous chloride cell is slightly heavier per unit of output." (PX—37, p. 204C, emphasis ours)

In their Engineering Bulletin the Burgess Battery Company, another supplier of defendant, stated:

"Most Burgess Reserve Type Power Units are available in either silver chloride-magnesium or cuprous chloride-magnesium construction.

"The silver chloride-magnesium types are more stable, have higher output ratings per unit volume, and are somewhat smaller and lighter than cuprous chloride-magnesium types *having equivalent electrical characteristics.*" (PX-18, p. 8) (Emphasis ours)

Dr. Mantell was asked:

"Q. Do you agree, Doctor, in your opinion that silver chloride-magnesium types and cuprous chloride-magnesium types have equivalent electrical characteristics?

"A. Yes sir." (R-382)

119. [Br. pp. 106-7] Dr. Mantell testified that the chemical properties of cuprous chloride and silver chloride were of a like nature and that silver chloride functions similarly in the (Adams) battery system (R-171). He agreed with the statements made by Blake and Pucher in their articles published back-to-back in the Journal of the Electrochemical Society for August, 1952, pages 202C-204C (PX-37), that silver chloride and cuprous chloride have the same reactions (R-296) that the output curves of the battery systems employed silved chloride and cuprous chloride are the same, that silver chloride and cuprous chloride have the same char-
[fol. 882] acteristics (R-297).

Dr. Mantell further pointed out that according to the Electric Storage Battery letter (TX-1) and the Pucher patents (TX-3, 4 and 5), therein referred to, the fact that

4% of silver chloride could be added to cuprous chloride to form a cathode showed that silver chloride and cuprous chloride are equivalents in the magnesium water battery system. Dr. Mantell was asked:

> "Q. Doctor, what is the significance to you that cuprous chloride and silver chloride are mixed together to form an electrode system?
>
> "A. Cuprous chloride and silver chloride are equivalents, and each one functions the same as the other, and each one is able to take the place of the other." (R-276)

120. [Br. p. 107] Dr. Mantell pointed out that it is not necessary to use carbon in silver chloride batteries as is often done in cuprous chloride batteries; that the same result could be obtained by using silver in silver chloride electrodes as is obtained by using carbon in cuprous chloride electrodes (R-207). The chemical equivalency of silver chloride and cuprous chloride is thereby further established as the effect of the addition of carbon is generally regarded as adding conductivity (R-203, 527). Silver is a well known conductor as Volta shows (PX-42, pp. 1-3).

121. [Br. p. 107] Dr. Mantell analyzed the statements concerning the characteristics of the silver chloride battery set forth in PX-39, the published statement by Mullen and Howard of the Burgess Battery Co., a supplier of the defendant, and therein pointed out that cuprous chloride cells have the same characteristics as the ones set forth for silver chloride (R-369, 370, 376, 378-9).

122. [Br. pp. 107-8] Dr. Mantell examined and discussed the silver chloride battery (TX-18) produced by defendant, [fol. 883] which it was stipulated had been procured within the six years prior to the filing of this suit (Memorandum of Pre-Trial Conf., par. 3). Dr. Mantell testified that this battery had all the elements of claims 1 and 10, except that silver chloride had been substituted for cuprous chloride. He further testified that in any way the silver chloride cathode could have been made, the result was a unified structure and this was true whether it had been made by electrolytic deposition or by liquefaction by heat or any other like process (R-362-367). There was no countervailing testimony on the part of defendant and Dr. Mantell's statements were not challenged on cross.

123. [Br. p. 108] Defendant's silver chloride battery (TX-18) infringes claims 1 and 10 of the Adams patent.

124. [Br. p. 108] The batteries of defendant, TX-7, 8 and 9, infringe claims 1 and 10 of the Adams patent. So also do batteries made in accordance with the letters of contractors set forth in TX-1.

* * * * * * *

[fol. 884] IN THE UNITED STATES COURT OF CLAIMS

No. 163-60

BERT N. ADAMS, et al., Plaintiffs,

vs.

THE UNITED STATES, Defendant

DEFENDANT'S BRIEF—Filed February 1, 1962

WILLIAM H. ORRICK, JR.,
Assistant Attorney General.

PAUL F. ARSENEAU,
Attorney, Department of Justice.

[fol. 885] INDEX

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* * * * * * *

[fol. 886] IN THE UNITED STATES COURT OF CLAIMS

163-30

BERT N. ADAMS, et al., Plaintiffs,

v.

THE UNITED STATES, Defendant

DEFENDANT'S OBJECTIONS TO PLAINTIFFS' REQUESTED FINDINGS OF FACT AND CONCLUSIONS OF LAW—Filed February 1, 1962

WILLIAM H. ORRICK, JR.,
Assistant Attorney General.

PAUL F. ARSENEAU,
Attorney, Department of Justice.

* * * * * * *

[fol. 887] (116) Objection is made to this finding as being misleading, inaccurate, and conclusory.

The citation of silver chloride art against a patent claiming the use of cuprous chloride is *not* any type of admission. Defendants, in seeking to establish the obviousness or lack of invention involved in using a *copper* chloride; are entitled to show that *many* metallic chlorides such as lead chloride, iron perchloride, mercuric chloride, platinum chloride, and silver chloride were notoriously old as depolarizers. (Niaudet; DX-1) Defendant, after testimony by his expert on the closest metallic chloride, can then query the obviousness of making the mental jump to the *specific* metallic chloride which is claimed in the patent in suit. The use of a closely related metallic chloride already in the public domain, which the expert uses as his spring board for the query as to obviousness, is *not* an admission that such compound is identical with the claimed compound. The oft reiterated statements in the record concerning the one-for-one equivalence between CuCl and AgCl are all made by plaintiffs. (R-276)

[fol. 888] (117) Objection is made to this finding as being misleading, and a mis-citation of the art of record.

The disclosed use of a cuprous chloride depolarizer in the British Patent to Wensky No. 49 (DX-20), following criticism of the costliness of the Marie Davy silver chloride cell, documents the *obviousness of substituting* CuCl for AgCl as a depolarizer material. This reference corroborates the testimony of Dr. White, defendant's expert, on the fundamental lack of inventiveness involved in making the substitution. (R-622)

The proposed finding is also misleading in that, regardless of what British Patent No. 49 discloses with respect to the uses of silver chloride and cuprous chloride, such a patent cannot be dispositive "of the issue", as to whether *defendant* made any admission equating silver chloride to cuprous chloride. The lack of any record citation in the proposed finding, is answer enough to this contention.

(118) Objection is made to this finding as being misleading, inaccurate, and contrary to the record.

Published statements of defendant's suppliers, in the first place, do not relate to components "in the Adams system." In CX-2, PX-37, PX-18, cited by plaintiffs, no men-

[fol. 889] tion whatsoever of "fused" type electrodes, constructed in accordance with Adams' teachings, is made. (See Objections 102, 104, supra)

Moreover, the term "electrochemical equivalency" as used by plaintiffs, is meaningless. In PX-16, an article in Electrical Engineering entitled "Special Purpose Batteries" mention is made of a zinc, potassium hydroxide-silver peroxide system. This occurs in the same article which treats magnesium-cuprous chloride cells. References to possible good low temperature performance are made. According to plaintiffs' usage of the terms, such cell is the electrochemical equivalent of the Adams' CuCl battery and would fall within its claims. Insofar as batteries having "similar characteristics" are concerned, a lead-acid automobile battery with a flat load curve, according to plaintiffs' definition, would be "electrochemically equivalent" to Adams' cell. Every electrolytic couple which can be built to give a result resembling performance of another such couple is not necessarily an electrochemical equivalent thereof.

(119) Objection is made to this finding as being misleading, inaccurate, and contrary to the record.

The testimony of Dr. Mantell at the cited page (R-171) [fol. 890] in connection with the comparison of metallic chlorides, is *not* keyed either to the "Adams battery system", or to the Adams patent disclosure, in any way.

Moreover, Dr. Mantell could not "agree with" the authors Blake and Pucher (PX-37) that silver chloride and cuprous chloride have the "same reactions", since no such statement appears in either article. As far as *comparing* the reactions, plaintiffs' expert, when he was asked if he understood the chemical reactions in the magnesium-cuprous chloride, or magnesium silver chloride systems, admitted frankly that he *did not*. (R-397)

[fol. 891] (120) Objection is made to this finding as being misleading, inaccurate, and unsupported by the record.

The comparison of the use of carbon (a poor conductor) in a mix to improve conductivity, with the use of silver (an excellent conductor) in another type of mix to improve conductivity, is nowhere to be found in the record.

(121) Objection is made to this finding, as being misleading and deceptive, by omission.

The art of record is replete with fused AgCl-zinc-water batteries. Plaintiffs in citing Dr. Mantell's testimony on PX-39, concerning the substitution of AgCl for CuCl, have omitted that the obviousness of substituting magnesium for zinc as an electrode material, as soon as magnesium became available, was expressly disclosed in such article. (R-600) Dr. Mantell had earlier testified that this availability had occurred by 1900. (R-167)

(122) Objection is made to this finding as being inaccurate, misleading, and contrary to the record.

Plaintiffs' expert, Dr. Mantell, could not and did not testify that TX-18 had all the elements of Claims 1 and 10. Claim 1 of the Adams patent calls for a "fused" chloride. [fol. 892] All of the questions asked by plaintiffs' counsel and all of the testimony by the witness on TX-18 electrodes was based on "assuming" (R-363) and "supposing" (R-364) the silver chloride had been formed by one or more hypothetical techniques.

As a matter of fact, there is absolutely no credible evidence of record as to *how* the silver chloride electrode in TX-18 was made. The Burgess Brochure (PX-18), the Blake Article (PX-37), and the Mullen et al article (PX-39) were all accepted in evidence with the understanding that they were hearsay with respect to contractor's techniques.

Defendant, of course, was not obliged to offer countervailing evidence, after plaintiffs' counsel admitted *on the record* his lack of knowledge concerning an allegedly infringing structure, and based all questions on *assumptions* and *suppositions*. (R-363, 365)

(123) Objection is made to this finding as being misleading, inaccurate, and contrary to the record.

Claim 1 of the Adams patent requires a "fused" electrode. As set forth in Objection 122, supra, plaintiffs suffered a total failure of proof in attempting to fit this limitation to the accused battery TX-18. Claim 10 of Adams patent requires an electrode "fused with carbon". No [fol. 893] proof concerning the use of carbon in TX-18 was offered, and plaintiffs' expert, Dr. Mantell, testified that one does not ordinarily use carbon in silver-chloride water-activated batteries. (R-207)

(124) Objection is made to this finding as being misleading, inaccurate, and wholly unproved by the record.

The accused batteries TX-7, TX-8, TX-9 do not infringe any of the claims of the Adams patent, for the reasons detailed, in extenso, throughout the preceding objections. Contrary to plaintiffs' assertion, and for the reasons set forth in the preceding Objections, in Defendant's Proposed Findings, and in Defendant's Brief, the batteries made in accordance with the contractor's letters included in TX-1 do not infringe any of the claims of the Adams patent.

* * * * * * *

[fol. 894] [File endorsement omitted.]

[fol. 895] [File endorsement omitted]

IN THE UNITED STATES COURT OF CLAIMS

No. 163-60

BERT N. ADAMS, EMMA ADAMS, GEORGE HALLINGBY (individually and as Executor of the Estate of Olaf Hallingby, deceased), JANE MAESEL, IRIS PETRY, LEWIS M. SCHOTT, MARY ELLEN HALLINGBY SEIMERS, and HELEN LOUISE SUTCLIFFE (individually and as Executrix of the Estate of Ernest M. Sutcliffe, deceased),

v.

THE UNITED STATES

OPINION AND FINDINGS OF FACT OF COMMISSIONER—Filed January 28, 1963

To the honorable the CHIEF JUDGE AND ASSOCIATE JUDGES OF THE UNITED STATES COURT OF CLAIMS:

The following opinion of the trial commissioner, findings of fact, and recommended conclusion of law are submitted under the order of reference and the order of the court issued pursuant to the provisions of Rule 45(a):

OPINION OF COMMISSIONER

This is a claim for compensation under 28 U.S.C. § 1498, for unlicensed use of a patented invention, for compensation under 28 U.S.C. § 1491 for breach of implied contract, and for compensation under the Mutual Security Acts of 1951 and 1954, 22 U.S.C. §§ 1668 (repealed in 1954) and 1758, respectively.

The subject matter concerns an electric battery disclosed in United States Letters Patent 2,322,210, issued June 22, 1943, to Bert N. Adams, one of the petitioners herein. The patent disclosure, patent claims in suit, and the accused batteries used by defendant are described in the accompanying findings of fact. The several issues of law involved are discussed in the following comments.

[fol. 896] One of the important issues raised by the pleadings is whether the fact that the individual constituents of the Adams battery have been long known in the art and have been used in various combinations in numerous batteries developed in the past, negates the essential element of novelty required in a valid patent, even though the specific combination used by Adams was never before disclosed and produced unusual and unexpected results. The defendant has cited some 24 prior disclosures against the Adams patent. These citations, some of which date back as far as 1880, show that each of the elements of the Adams battery was well known in the battery-making art at least 50 years before the Adams application for letters patent. Adams, after all these many disclosures, put together the specific *combination* of elements that resulted in a lightweight cell which could be exposed to extreme temperature conditions and which, upon activation by water, produced a constant electric potential. The volume of the prior art points to the novelty of the Adams invention. It has been frequently held that voluminous prior art indicates that none of the prior art is in point or indicates that prior attempts to solve the problem have not met with success. In the case of *Reynolds v. Whitin Mach. Works*, 167 F. 2d 78 (4th Cir. *1948*), 76 U.S.P.Q. 551, it was held, at pages *83* and *84*:

> Defendant has cited 21 patents as basis for its contention that complainants' invention is lacking in novelty; and this in itself is evidence of the weakness of the con-

> tention. Such a citation of so many prior patents almost always means either that none of them is in point and that the patentee has brought together for the purpose of his invention devices to be found in prior patents of different character, or that there have been prior attempts to solve the problem with which he was confronted which have not met with success.

The fact that it was known to one skilled in the battery art that the various individual components of the Adams battery could be used in designing batteries, does not make the Adams invention obvious and unpatentable within the meaning of 35 U.S.C. § 103. The pertinent portion of this section reads as follows:

> A patent may not be obtained though the invention is not identically disclosed or described as set forth in [for. 397] section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

The evidence presented during the trial shows that although the necessary materials and techniques were available to the battery experts for over 50 years, no one put them together, or recognized that the *combination* would work, or yield new and unexpected results. Further, the evidence shows that the invention constituted an important advance in the art and has had many successful uses. The courts have recognized that obviousness is negated where the patent teaches a solution which has long eluded the researchers in the art, even though all the elements required to provide the solution have been readily available. In *Goodyear Co.* v. *Ray-O-Vac Co.*, 321 U.S. 275, 60 U.S.P.Q. 386 (*1944*), in supporting the validity of a patent relating to a leakproof dry cell for a flashlight battery, Mr. Justice Roberts, writing for the Supreme Court, said, at page 279:

> Viewed after the event, the means Anthony adopted seem simple and such as should have been obvious to those who worked in the field, but this is not enough to

negative invention. During a period of half a century, in which the use of flashlight batteries increased enormously, and the manufacturers of flashlight cells were conscious of the defects in them, no one devised a method of curing such defects. Once the method was discovered it commended itself to the public as evidenced by marked commercial success. These factors were entitled to weight in determining whether the improvement amounted to invention and should, in a close case, tip the scales in favor of patentability. Accepting, as we do, the findings below, we hold the patent valid and infringed.

See also *Peerless Equipment Co.*, v. *W. H. Miner, Inc.*, 93 F. 2d 98 (7th Cir., *1937*), 35 U.S.P.Q. 396, and *Remington Rand Business Service, Inc.* v. *Acme Card System Co.*, 71 F. 2d 628 (4th Cir., *1934*), 22 U.S.P.Q. 1. While the use of any of the individual components of the Adams battery cell may have been obvious at the time of the invention, the [fol. 898] invention *as a whole* was not obvious, at the time the invention was made, to a person having ordinary skill in the art.

The fact that the Adams patent discloses only a single embodiment of his invention does not necessarily restrict the claims of his patent to that particular embodiment. The Adams patent discloses that the cuprous chloride electrode is made by heating cuprous chloride until it melts and then forming it into a cylindrical electrode by the use of a mold. The defendant alleges that since the cuprous chloride electrode is referred to in the specification and the claims as *fused*, the claims must be restricted to the type of electrode described in the specification of the patent. The facts show that the term *fused* may refer to unifying by means other than by the particular method described in the specification of the Adams patent. The description of an invention in the specification is required by 35 U.S.C. § 112, which reads in part as follows:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly con-

> nected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

It is evident that this section does not require an inventor to disclose every possible way in which his invention may be used, nor does it limit the claims of the patent to the particular mode which the inventor considers best at the time of filing his application for patent. In the case of *Smith* v. *Snow*, 294 U.S. 1, 24 U.S.P.Q. 26 (*1935*), Mr. Justice Stone, in discussing this point, said, at page *11:*

> We may take it that, as the statute requires, the specifications just detailed show a way of using the inventor's method, and that he conceived that particular way described was the best one. But he is not confined to that particular mode of use since the claims of the patent, not its specifications, measure the invention.

It is clear that the Adams patent claims are not limited to covering only electrodes made in the specific manner described in the specification.

[fol. 899] The fact that in some instances silver chloride may be equivalent to cuprous chloride does not entitle the plaintiffs to extend the coverage of the Adams patent claims to cover silver chloride electrodes as well as cuprous chloride electrodes. Neither the specification nor the claims of the Adams patent mention that silver chloride may be used as the electronegative electrode. However, plaintiffs allege that silver chloride and cuprous chloride were well known electrochemical equivalents prior to the Adams invention, and that cells made with silver chloride electrodes also infringe the claims of the patent. The doctrine of equivalents is based on the theory that one should not be able to avoid infringement of a patent merely by substituting an equivalent for one of the elements recited in a claim. The doctrine is invoked when a person reasonably skilled in the art would have known of the interchangeability of an ingredient not disclosed in the patent with one that was. *Graver Mfg. Co.* v. *Linde Co.*, 339 U.S. 605, 85 U.S.P.Q. 328 (*1950*). It cannot be said that one reasonably skilled in the battery art would have known of the interchangeability of cuprous chloride and silver chloride in the Adams

battery. The battery disclosed in the Adams patent is made up of *particular* components which unexpectedly produced a battery having unique characteristics. The Adams patent specification is completely silent as to any other components which would work equally well in his battery. The public was left to mere speculation or experimentation to determine whether in all the known battery components there was any other component which could be used in place of the particular components which Adams disclosed. In considering equivalency, the context of the patent, the prior art, and the particular circumstances of the case must also be weighed. In the present case, the validity of the Adams patent is sustained on the ground that, in a crowded art, Adams selected *specific* components from the group of known battery components and found that the *combination* of these specific components resulted in a workable battery having unique and unexpected characteristics. The unexpectedness of the Adams invention is evidenced by the fact that, even today, the theory upon which the Adams battery operates is known. To allow the plaintiffs to expand the [fol. 900] Adams patent claims to include other allegedly equivalent components, which were also in the known group of battery components at the time of the Adams invention, would be contrary to the finding of validity. It was stated in *Union Carbide & Carbon Corp.* v. *Graver Tank & Mfg. Co.*, 196 F. 2d 103, *112*, 93) U.S.P.Q., 137 (7th Cir., *1952*), that:

> In our opinion, the application of the doctrine of equivalency in this case is to ignore the teachings of the patent, the representation upon which the claims in suit were allowed and, more pointedly perhaps, the representations by which their validity has been sustained in the courts. While the difference between plaintiff's composition and those accused may not be great, it is that difference which distinguished plaintiff's composition from the prior art and which enabled it to sustain the validity of its grant. It is now estopped from claiming otherwise.

The fact that Adams submitted disclosures of his invention to the National Inventors Council and personnel of defendant's Signal Corps, and Navy, coupled with the fact

that the defendant has used the Adams invention, does not establish an express or implied contract between the plaintiffs and defendant. The plaintiffs allege that certain publications of the National Inventors Council contained general offers to the public to enter into a unilateral contract which could be accepted by disclosing inventions to the Council and become binding when a condition precedent, use of the invention by the defendant, was fulfilled. Plaintiffs also allege that the disclosure of the Adams battery to personnel of the Signal Corps and the Navy, coupled with the subsequent use of the invention by the defendant, establishes an implied contract. It is not believed that either of these contentions has been successfully made out. With regard to any contract with the National Inventors Council, the evidence does not support the contention that defendant's publications in fact contained offers to enter into a unilateral contract. Further, the evidence does not establish that either the National Inventors Council or the personnel of the Signal Corps or the Navy had authority to make such an offer or enter into a binding contract on defendant's behalf. The facts alleged are not sufficient to prove the [fol. 901] existence of a contract, express or implied, between defendant and plaintiffs. *James J. Gearon, et al.* v. *United States,* 126 Ct. Cl. 548, 99 U.S.P.Q. 286 (*1953*); *Frederick P. Fulmer* v. *United States,* 144 Ct. Cl. 812 (*1959*).

Claims 1 and 10 of the Adams patent have been specifically relied upon by the plaintiffs. These two patent claims, set forth in finding 12, each define a combination including a magnesium electropositive electrode and a fused cuprous chloride electronegative electrode. Claim 10 also recites the presence of a carbon catalytic agent in the electronegative electrode. The accused Eagle-Picher and Ray-O-Vac battery units identified in findings 25 and 26 as trial exhibits 7, 8, and 9, each include a magnesium electropositive electrode and a fused cuprous chloride electronegative electrode as set forth in more detail in finding 34. These batteries infringe claim 1 of the Adams patent. The accused Burgess battery unit identified in findings 28 and 37 as trial exhibit 18 contains a silver chloride electronegative electrode and does not infringe the claims of the Adams patent.

Summarizing, it is found that plaintiffs are the rightful owners of the Adams patent, that the patent is valid, that

the invention claimed therein has been used by defendant without license of the owners, that the plaintiffs are entitled to recover compensation for such use, and that the extent of liability should be determined in further proceedings pursuant to Rule 38(c).

Findings of Fact

1. This is a suit involving a patent claim and a contract claim brought under the provisions of 28 U.S.C. §§ 1491 and 1498 and 22 U.S.C. §§ 1668 (repealed) and 1758. The parties have stipulated that this court has jurisdiction over all of the parties involved and over the issues raised by the petition and answer.

2. The patent claim is for reasonable and entire compensation for unauthorized and infringing use or manufacture by or for defendant, and for the unauthorized and infringing use within the United States in furtherance of the purposes of the Mutual Security Acts of 1951 and 1954 of United States Letters Patent No. 2,322,210 entitled "Battery" [fol. 902] which issued June 22, 1943, on an application for patent filed by Bert N. Adams, a plaintiff herein. This patent will be referred to hereinafter as the Adams patent.

3. The breach of contract claim is for reasonable and entire compensation for defendant's breach of an express or implied contract existing between defendant and plaintiffs relating to compensation for use or manufacture by or for defendant of batteries made in accordance with disclosures made to defendant by plaintiff Bert N. Adams.

4. At pretrial conference, the parties stipulated that upon proof of the manufacture by or for, or the use by or for, the defendant, of one or more articles alleged in the petition, or otherwise alleged on the record, to infringe the Adams patent, the issues of patent validity and of infringement of the patent by the defendant would be first determined upon full proofs, findings of fact, and argument of counsel. The parties further agreed that the accounting issue, including evidence as to the number of articles procured and/or the value of the patented invention, or the extent of the liability, if any, of the defendant, and the amount of reasonable and entire compensation, if any, due to plaintiffs on account thereof, would be deferred until

after the entry of the order of the court on the issues of patent validity and/or patent infringement.

5. The ownership of the Adams patent, the application therefor, and the claims against the defendant involved in this suit are as follows:

a. The application for patent was filed December 18, 1941, and from that date through January 14, 1942, ownership of the application and any claims arising during this period was: 10 percent in Olaf Hallingby (owned until July 16, 1959, by his heirs, Mary Seimers, George Hallingby, Iris Petry, and Jane Maesel), and 90 percent in Bert N. Adams.

b. From January 15, 1942, through January 16, 1942, owership of the application and the claims arising during this period was: 10 percent in Olaf Hallingby (owned until July 16, 1959, by his heirs, Mary Seimers, George Hallingby, Iris Petry, and Jane Maesel); 45 percent in Bert N. Adams, and 45 percent in Emma Adams.

[fol. 903] c. From January 17, 1942, through September 14, 1942, ownership of the application and the patent (which issued on June 22, 1942) and the claims arising during this period was: 10 percent in Olaf Hallingby (owned until July 16, 1959, by his heirs, Mary Seimers, George Hallingby, Iris Petry and Jane Maesel); 45 percent in Emma Adams; 1.35 percent in Ernest Sutcliffe (owned by his heir, Helen Sutcliffe, until July 16, 1959), and 43.65 percent in Bert N. Adams.

d. From September 14, 1942, through April 14, 1959, ownership of the application and the patent and the claims arising during this period was: 10 percent in Olaf Hallingby (owned until July 16, 1959, by his heirs, Mary Seimers, George Hallingby, Iris Petry, and Jane Maesel); 45 percent in Emma Adams; 0.9 percent in Ernest Sutcliffe (owned by his heir, Helen Sutcliffe, until July 16, 1959), and 44.1 percent in Bert N. Adams.

e. From April 15, 1959, through July 15, 1959, ownership of the patent and the claims arising during this period was: 10 percent in Olaf Hallingby (owned until July 16, 1959, by his heirs, Mary Seimers, George Hallingby, Iris Petry, and Jane Maesel); 0.9 percent in Ernest Sutcliffe (owned until July 16, 1959, by his heir, Helen Sutcliffe), and 89.1 percent in Bert N. Adams.

f. From July 16, 1959, through August 30, 1959, ownership of the patent and the claims arising during this period was 100 percent in Bert N. Adams.

g. After August 31, 1959, ownership of the patent (which expired June 21, 1960) and the claims arising during this period was 100 percent in plaintiff Lewis M. Schott.

6. Adams first became interested in batteries in the summer of 1939. While employed at the New York World's Fair, he studied various battery theories at home, and conducted experiments using various types of electrodes and electrolytes in batteries. Finally, Adams discovered that when cuprous chloride was used in combination with magnesium and water, the result was an operable battery.

[fol. 904] 7. Adams continued experimenting, and in 1940, after accidentally dropping cigarette ashes into the cuprous chloride which he was making into a cathode, he discovered that the addition of carbon improved the battery by increasing the current and providing a substantially level (constant) potential. Subsequent experiments taught Adams that a small addition of magnesium chloride to the electrolyte would increase the speed of activation of the battery and that the addition of a small amount of magnesium sulphate helped to clean the electrodes.

8. On December 18, 1941, Adams filed an application for patent in the United States Patent Office. This application resulted in the issuance of the Adams patent on June 22, 1943.

9. The Adams patent disclosed a battery comprised of a magnesium electropositive electrode (anode), a cuprous chloride electronegative electrode (cathode), and a water electrolyte. The distinctive characteristics of this battery are that it is light in weight, it uses ordinary water as an electrolyte, it may be manufactured and distributed in a dry condition and may be rendered serviceable by merely filling the container with ordinary water, it may be operated under extremely cold conditions, and, upon complete activation, it produces a linear (constant) potential which continues until the battery is substantially exhausted.

10. The Adams patent contains several illustrative drawings which are reproduced below.

[fol. 905]

June 22, 1943. B. N. ADAMS 2,322,210

BATTERY

Filed Dec. 18, 1941

Fig. 1.

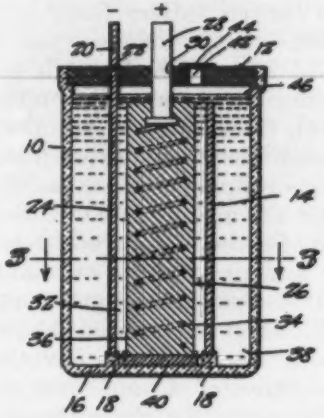


Fig. 2.

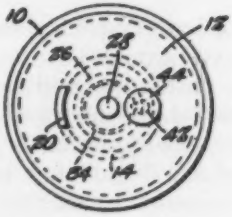
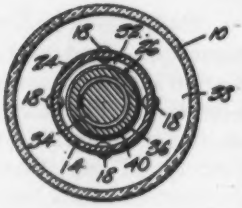


Fig. 3.



[fol. 906] 11. The specification of the Adams patent describes the drawings in part as follows:

Figure 1 is a sectional view of a battery in accordance with my invention;

Figure 2 is a top plan view; and

Figure 3 is a sectional view taken along the line 3—3 of Figure 1.

In the embodiment selected for illustration, I make use of a container 10 provided with a closure or cover 12 of insulative material. The container 10 may comprise glass or any other material which is waterproof. Inside the container 10 is arranged an electro-positive electrode 14 comprising pure magnesium. The electro-positive electrode 14 is in the form of an open ended tube of a length slightly less than the height of the container 10. Projecting upwardly from the bottom 16 of the container are notched ears 18 in which the lower end of the electro-positive electrode 14 is supported. An extension 20 is provided at the upper end of the electro-positive electrode 14, which extension projects through an opening 22 in the cover 12 to constitute one terminal of the battery. The outer surface of the electro-positive electrode 14 is provided with a coating of tar 24.

Arranged concentrically within the electro-positive electrode 14 is an electro-negative electrode 26 in the form of a cylinder coextensive in length with the electro-positive electrode 14. Embedded in the upper end of the electro-negative electrode 26 is a copper terminal 28 extending through an opening 30 in the cover 12. The electronegative electrode 26 is of uniform diameter less than the inside diameter of the electropositive electrode 14 so as to provide a space 32 for the liquid contained in the battery. To the terminal 28 is connected one end of a copper coil 34 embedded in the core 36. The electro-positive electrode 14 is of considerably smaller outside diameter than the inside diameter of the container 10 to provide a space 38 for the liquid, which space has communication with the space 32 at the bottom of the battery by reason of the ears 18 and also by reason of the fact that the electropositive electrode terminates short of the cover 12.

The body 36 of the electronegative electrode 26 comprises fused cuprous chloride (CuCL). In manufacturing the body 36, the coil 34 and the terminal 28 are arranged in a mold and the latter supplied with the requisite amount of cuprous chloride poured from a heated crucible. A piece of wood carbon is placed on [fol. 907] the top of the cuprous chloride in the crucible and the latter is heated to a temperature ranging between 400° and 500° centigrade at which the cuprous chloride may be poured. The wood carbon constitutes a catalytic agent which renders the electronegative 26 successful for the purpose intended, the exact chemical action being unknown to me.

After the electronegative electrode 36 is removed from the crucible, it is cooled and dipped in a 66° Baume solution of sulphuric acid. While still dripping wet, the electrode 26 is covered with aluminium powder to prevent oxidation thereof. The electrode 26 is now ready for use.

The lower end of the electrode 26 is rested on a wood block 40 on the bottom 16. Both terminals 20 and 28 are firmly anchored in the cover 12 so that all the parts are maintained in fixed relationship when assembled with the container.

12. Although all 11 claims of the Adams patent are in suit, plaintiffs have relied specifically on claims 1 and 10. The elements of these two claims are as follows:

Patent Claim 1

A battery comprising
a liquid container,
a magnesium electropositive electrode
inside the container
and having an exterior terminal,
a fused cuprous chloride electronegative electrode, and a terminal connected with said electronegative electrode.

Patent Claim 10

In a battery, the combination of

a magnesium electropositive electrode, and
an electronegative electrode comprising cuprous chloride fused with a carbon catalytic agent.

Validity Issue

13. Defendant urges that the patent is invalid on the grounds that the invention was fully anticipated by the prior art and is hence invalid under 35 U.S.C. § § 101 and 102, and that the invention was obvious to those skilled in [fol. 908] the art at the time that it was made, and is hence invalid under 35 U.S.C. § 103.

14. Defendant has cited 24 prior patents and publications, defendant's exhibits 1–24, identified as follows:

Elementary Treatise on Electric Batteries, Niaudet, 1880, pages ix 200–209;
Hayes patent 282,634, 1883;
Galvanic Batteries, Bottone, 1902, pages 172–177;
Primary Batteries, Carhart, 1891, pages 62–65;
Barrett patent 405,196, 1886;
Hard patent 457,116, 1891;
Hathaway patent 454,598, 1891;
Van Tenac patent 184,932, 1876;
Fink patent 434,593, 1890;
Pearson patent 512,055, 1894;
Practical Primary Cells, Codd, 1929, pages 1–3, 43, 44, 78–81, 110, 117;
Wood patent 1,696,873, 1928;
Ruben patent 1,920,151, 1933;
Jumau patent 2,078,143, 1937;
Manual of Chemistry, Simon, 1905, page 216;
Essentials of General Chemistry, Hopkins, 1946, pages 371, 372, period table;
Ferrabino British patent 301,923, 1928;
Thurnauer, et al. patent 552,211, 1895;
Skrivanoff British patent 4,341 of 1880;
Wensky British patent 49 of 1891;
Copper-Zinc and Copper-Tin Alloys, Laurie, 1888, pages 104–116;

Parkhurst patent 269,454, 1882;
Heil patent 653,770, 1900;
Harrison patent 1,522,121, 1925.

15. Nine of these publications disclose batteries utilizing silver chloride; none of these items disclose the use of magnesium. Four of these publications disclose batteries with magnesium as a component; none of these disclose the use of silver or cuprous chloride. Three of these publications disclose the use of cuprous chloride as a single component; none of these disclose its use in conjunction with magnesium. Two of these publications disclose the use of neither magnesium, nor cuprous chloride, nor silver chloride. A total of 18 of defendant's 24 cited publications disclose either none of the components of the Adams system or at most one single component of the system; none of these 18 items disclose the combination of even two of the components. Only [fol. 909] three of defendant's anticipatory references disclose more than one component of the Adams system.

16. The Codd textbook (on page 22) mentions magnesium but only for use in a cell in which the other electrode is copper and the electrolyte is dilute sulfuric acid. On page 44, in discussing another battery entirely, Codd discusses silver chloride as an eletrode. There is no suggestion in Codd that the materials could be combined in a battery.

17. The Skrivanoff foreig. patent discloses a battery having an electrode of magnesium, an electrode comprising cuprous chloride *mixed together with* some seven other substances, and a strong electrolyte. The evidence establishes that the disclosure of this very old patent is inoperative.

18. The Niaudet treatise (1880) discloses a battery having an electrode of silver chloride, an electrode of zinc, and plain water as an electrolyte. This disclosure contains no suggestion that magnesium might be substituted for zinc in this battery.

19. The Harrison patent, cited by defendant to show the state of the art, discloses a battery in which the electrodes are immersed in sea water on opposite sides of a ship. One electrode is magnesium and the other is copper. The electrolyte is the sea water. The patent explains that because of exposure to sea water, the potential characteristics and cur-

rent yield for a copper electrode having a given area will gradually improve.

20. The Simon article and the Hopkins article, which were not cited by the defendant as anticipatory references, show that magnesium is an alkaline earth metal. The Jumau patent discloses that the electrolyte in a lead chloride-magnesium battery may be a dilute solution of an alkaline earth salt, such as a sulphate or a chloride.

21. Summarizing findings 14 through 20, the cited publications and patents do not anticipate the invention defined in the several claims of the Adams patent.

22. Each of the elements of the several claims of the Adams patent was individually old in the battery-making art at the time of the filing of the Adams application for the patent here in suit. While there is evidence of a definite need for [fol. 910] a battery having the characteristics of the Adams battery, those skilled in the art failed to develop one for a period of over 50 years, during which time all of the necessary ingredients were available. There is no evidence that anyone had ever before suggested the specific *combination* of elements which make up the Adams battery nor that anyone had ever before suggested that such a battery would have a substantially constant potential, could be operated under extreme temperatures, and could be operated with ordinary or distilled water.

23. The Adams invention was the first practical, water-activated, constant potential battery capable of operation at low temperatures. When Adams first disclosed his invention to others skilled in the art, he did not know its theory of operation and it was received with considerable skepticism. However, this development was subsequently recognized throughout the industry as an extremely important step in rounding out the sources of battery-furnished power, and filling important, long-standing needs of both civilian and military natures.

24. Summarizing findings 22 and 23, the Adams invention was not, as a whole, obvious, at the time the invention was made, to a person having ordinary skill in the battery art.

INFRINGEMENT ISSUES

25. Plaintiffs contend that batteries embodying the invention and infringing the claims of the Adams patent were used or manufactured by or for defendant without authorization or license of plaintiffs. The parties have stipulated that the batteries identified as trial exhibits 7, 8, and 9 were procured by and delivered to the defendant within the 6-year period preceding the filing of the petition. The parties further stipulated that articles made as described in trail exhibit 1 were procured by and delivered to the defendant within the 6-year period preceding the filing of the petition.

26. Trial exhibit 7 is an Eagle-Picher battery unit designated BA–259/AM. Trial exhibit 8 is a Ray-O-Vac battery unit designated BA–292/AM. Trial exhibit 9 is a Ray-O-Vac battery unit designated BA–253/U.

[fol. 911] 27. Trial exhibit 1 includes a letter from The Electric Storage Battery Company, stating that they have supplied to the defendant batteries having cuprous chloride plates made in accordance with United States Letters Patent Nos. 2,640,090, 2,640,091, and 2,667,527. These three patents issued on applications filed after the Adams patent issued. Trial exhibit 1 also includes a letter from Burgess Battery Company stating that the batteries produced by Burgess had a plate made of a paste of cuprous chloride, plastic binder, and graphite. Trial exhibit 1 also includes a letter from The Eagle-Picher Company stating that all the magnesium cuprous chloride batteries which have been produced by Eagle-Picher have been made in accordance with the process outlined in United States Letters Patent No. 2,636,060 and/or Reissue No. 23,883. These two patents issued to the defendant, as represented by the Secretary of the Army, on applications filed after the Adams patent issued. Trial exhibit 1 also includes a letter from Ray-O-Vac Company stating that all of the batteries furnished to the defendant by Ray-O-Vac have had positive plates made in accordance with the process outlined in Patent No. 2,636,060 or Reissue No. 23,883, noted above, by a process involving subjecting a mixture containing cuprous chloride to pressure in a tableting machine to form pellets.

28. Trial exhibit 18, a Burgess battery unit designated X10183, is a water-activated, magnesium and silver chloride

battery introduced by defendant as illustrative of procurement of such devices during the 6-year period next preceding the filing of the petition.

29. Patents Nos. 2,640,090, 2,640,091, and 2,667,527, which are referred to in finding 27, teach a water-activated, magnesium and cuprous chloride battery having a pasted grid type cuprous chloride plate made by mixing cuprous chloride with silver chloride and water, and pasting the mixture on a copper wire screen.

30. Patent No. 2,636,060, referred to in finding 27, teaches a process for making cuprous chloride electrodes for water-activated, magnesium, cuprous chloride batteries. The cuprous chloride electrodes are made by making a pasty mixture of cuprous chloride and water and pasting the mix-
[fol. 912] ture on wire screens. Patent Reissue No. 23,883, referred to in finding 27, teaches a process for making cuprous chloride electrodes for water-activated, magnesium, cuprous chloride batteries. The cuprous chloride electrodes are made by making a paste of cuprous chloride, a highly polymeric substance and an organic solvent, and pasting the mixture on wire screens.

31. Cuprous chloride is available commercially as a powder. To function as an electrode, the powder must be formed by some means into electrode shape. There are several methods of forming cuprous chloride into electrode shape. One method, which is suggested in the Adams patent, is to place the cuprous chloride in a crucible and heat the crucible until the cuprous chloride is pourable. Then the cuprous chloride is poured into a mold where it is allowed to solidify. This "candlestick" method was known prior to 1880. Another method is to add water to cuprous chloride to form a pourable slurry, which, upon drying, hardens into a unified mass. Still another method is to add toluene to cuprous chloride to form a pourable slurry which, upon drying, hardens into a unified mass.

32. Defendant alleges that by the use of the term *fused* cuprous chloride in the claims the Adams patent is limited to batteries using cuprous chloride electrodes made by the *heat* method. The method of forming the cathode makes no substantial difference in the electrochemical properties of cuprous chloride, whether the method be liquidification by heat, water, or organic material, such as benzene or toluene.

There was considerable testimony at the trial both directly and indirectly relating to the term *fused*. Viewing this testimony as a whole, it appears that the term *fused* is used by some people as meaning unified only by heat. This limitation is by no means universally accepted and other people use the term as meaning unified by any one of a number of methods. One of the definitions given for *fuse* in *Webster's New International Dictionary* (1934 Edition), page 1022, reads: "To unite or blend, as if melted together." The term *fused* as used in the claims of the Adams patent is found to encompass unification or uniting by various methods and is not limited to unification or uniting by heat.

[fol. 913] 33. Each of Patent Nos. 2,640,090, 2,640,091, 2,667,527, 2,636,060, and Reissue No. 23,883 teaches a unified cuprous chloride electrode which is *fused* within the meaning of the term as used in the Adams patent and claims.

34. Each of trial exhibits 7, 8, and 9 is a pile-type battery. They each have bibulous material which acts as a liquid container, a magnesium electropositive electrode inside the container having an exterior terminal, a fused cuprous chloride electronegative electrode, and a terminal connected with said electronegative electrode.

35. The evidence is inconclusive and insufficient to determine whether there is carbon in the electronegative electrodes of trial exhibits 7, 8, and 9, as required by the recital of Adams claim 10. However, since each of these exhibits contains each of the elements of claim 1, it is unnecessary to pass upon this question.

36. The cuprous chloride plates manufactured by The Electric Storage Battery Company, Burgess Battery Company, The Eagle-Picher Company, and Ray-O-Vac Company, as described in trial exhibit 1, are *fused* within the meaning of the term as used in the Adams claims.

37. Trial exhibit 18 is a Burgess battery, which includes a liquid container, a magnesium electropositive electrode inside the container having an exterior terminal, a fused silver chloride electronegative electrode, and a terminal connected with said electronegative electrode. It does not have a cuprous chloride electrode.

38. Summarizing findings 25 through 37, claim 1 of the Adams patent has been infringed by trial exhibits 7, 8, and

9. Further, the cuprous chloride plates manufactured by The Electric Storage Battery Company, Burgess Battery Company, The Eagle-Picher Company, and Ray-O-Vac Company, as described in trial exhibit 1, would infringe claims in the Adams patent if used in a battery otherwise covered by the Adams claims. Trial exhibit 18 does not infrinbe claims of the Adams patent.

CONTRACT ISSUE

39. The plaintiffs allege that defendant, through its National Inventors Council, made a general offer of a unilateral [fol. 914] contract for acceptance by any member of the public by submission of a useful suggestion, with use by the defendant as a condition precedent to liability of defendant. Further, the plaintiffs allege that Adams accepted the offer by sending disclosures of his invention to the defendant, and that the condition precedent to defendant's liability has been fulfilled by defendant's use of the invention.

40. It is found that on January 7, 1942, Adams disclosed his invention to the National Inventors Council; that on January 10, 1942, Adams disclosed his invention to The Chief Signal Officer of the U.S. Army, and that on January 8, 1942, Adams disclosed his invention to the Navy Department. The National Inventors Council replied, asking Adams for more information, which Adams then supplied. Subsequently, Adams informed the National Inventors Council that he was about to receive a patent on the battery, and through the Council he was able to obtain a priority for purchasing magnesium. Both the Signal Corps and the Navy showed immediate interest in the disclosure, and Adams made trips to both Washington, D.C., and Fort Monmouth, New Jersey, where he turned over samples of his battery and made a complete disclosure of his invention to various representatives of the two branches. .Subsequently, Adams was in further contact with the personnel at Fort Monmouth and delivered or sent additional information and samples for testing to Fort Monmouth at no expense to the Government. Both the Navy and the Signal Corps finally concluded that the cell offered great promise.

41. The National Inventors Council issued two documents which were available to Adams. The first document was

Information Bulletin No. 1–Revised, dated March 1941, and contained, *inter alia*, the following statements:

> The submission to the National Inventors Council, under the provisions contained herein, of any description, drawing or other data pertaining to an invention is solely for the purpose of determining its military or naval value. Its acceptance by the Council does not legally obligate the United States Government or act as an estoppel under the patent statutes.
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> * * * * * * *
>
> [fol. 915] The Council has no authority to consider the question of compensation for the use of a suggestion or invention by any Government Department or agency. Should an invention be utilized, the matter of compensation will be referred to the Executive Department of the Government making use of the product embodying the invention. Final settlement for the acquirement of rights can then be arranged between the inventor and the appropriate official of the Department making the purchase.
>
> The amount of compensation can be considered only after tender of the suggestion or invention, and its adoption by an executive branch of the Government. The creation of the Council does not in any way affect the existing laws or practices of the Government Departments as to compensation.

The second document was Information Bulletin No. 2—Revised 1942, and contained, *inter alia*, the following statement:

> * * * In such event, the appropriate departments of the Army and Navy then deal directly with the inventor in making the necessary arrangements for the use of the invention. The Council itself does not consider the question of compensation or contracts between inventors and the Army or Navy. The negotiation of such contracts is conducted by the appropriate Military and Naval authorities.

42. In view of the statements quoted in the previous finding, it is found that the two documents from the National Inventors Council did not constitute an offer to enter into a binding contract. Additionally, the evidence does not warrant a finding that the National Inventors Council, or any of their personnel equal with whom Adams was in contact, had authority to enter into a binding contract on behalf of defendant.

43. Summarizing findings 39 through 42, it is found that the evidence has not established a contract, either express or implied, between the plaintiffs and the defendant regarding the Adams invention.

[fol. 916] RECOMMENDATION FOR CONCLUSION OF LAW

Upon the foregoing findings of fact, which are made a part of the judgment herein, the court concludes as a matter of law that United States Letters Patent 2,322,-210 is valid; that the invention covered by said patent was used by defendant without authorization of the patent owners, and that plaintiffs are entitled to recover reasonable and entire compensation for such unauthorized use, and judgment will be entered to that effect. The extent of liability will be determined in further proceedings before a trial commissioner, pursuant to Rule 38 (c).

Respectfully submitted, Donald E. Lane, Commissioner.

[fol. 917] [File endorsement omitted]

IN THE UNITED STATES COURT OF CLAIMS

No. 163–60

BERT N. ADAMS, et al., Plaintiffs,

vs.

THE UNITED STATES, Defendant

BEING A VERBATIM COPY OF THE COMMISSIONER'S OPINION AND FINDINGS OF FACT WITH CITATIONS TO THE RECORD—Filed August 12, 1963.

JOHN A. REILLY,
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165 Broadway,
New York 6, N. Y.

Of Counsel: KENYON & KENYON, WILLIAM J. UNGVARSKY

[fol. 918] TABLE OF ABBREVIATIONS

Abbreviation	Meaning
Bull.	Bulletin
CX	Commissioner's Exhibit
DX	Defendant's Exhibit
l. [s]	line [s]
Memo	Memorandum
p.	page
par.	paragraph
PX	Plaintiffs' Exhibit
R	Record
Stip.	Stipulation
TX	Trial Exhibit

[fol. 919] IN THE UNITED STATES COURT OF CLAIMS

No. 163–60

BERT N. ADAMS, EMMA ADAMS, GEORGE HALLINGBY (individually and as Executor of the Estate of Olaf Hallingby, deceased), JANE MAESEL, IRIS PETRY, LEWIS M. SCHOTT, MARY ELLEN HALLINGBY SEIMERS, and HELEN LOUISE SUTCLIFFE (individually and as Executrix of the Estate of Ernest M. Sutcliffe, deceased),

v.

THE UNITED STATES

OPINION AND FINDINGS OF FACT OF COMMISSIONER—
Filed January 28, 1963

To the honorable the Chief Judge and Associate Judges of the United States Court of Claims:

The following opinion of the trial commissioner, findings of fact, and recommended conclusion of law are submitted under the order of reference [dated May 10, 1960] and the order of the court issued pursuant to the provisions of Rule 45(a):

OPINION OF COMMISSIONER

This is a claim for compensation under 28 U.S.C. §1498, for unlicensed use of a patented invention, for compensation under 28 U.S.C. §1491 for breach of implied contract, and for compensation under the Mutual Security Acts of 1951 and 1954, 22 U.S.C. §§1668 (repealed in 1954) and 1758, respectively [Petition, pars. 1 and 2].

The subject matter concerns an electric battery disclosed in United States Letters Patent 2,322,210, issued June 22, 1943, to Bert N. Adams, one of the petitioners herein [TX-10; Petition, par. 1]. The patent disclosure, patent claims in suit, and the accused batteries used by defendant are described in the accompanying findings of fact. The several issues of law involved are discussed in the following comments.

[fol. 920] One of the important issues raised by the pleadings is whether the fact that the individual constit-

nents of the Adams battery have been long know in the art [R-167, 175, 178-81, 189-96, 449, 636-37; PX-42, p. 2; DX-1 thru DX-24] and have been used in various combinations in numerous batteries developed in the past [DX-1 thru DX-24; see particularly PX-42, R-636; DX-1, p. 202, R-181-82; DX-19, DX-21, R-167], negates the essential element of novelty required in a valid patent, even though the specific combination used by Adams was never before disclosed [See Comm. Find. No. 15, *infra,* and annotations thereto] and produced unusual and unexpected results [R-80-1, 96, 156, 164-5, 210, 307-08, 309, 310-11, 313, 315-6, 327; PX-16, p. 701; PX- 18, p. 2; PX-19, p. 1; PX-37, pp. 203C-204C; TX-10, p. 1, col. 1, ls. 2-14 and p. 2, col. 1, ls. 10-17; TX-12 pp. 11-12; TX-15, pp. 1-5, 15-16]. The defendant has cited some 24 prior disclousures against the Adams patent [DX-1 thru DX-24]. These citations, some of which date back as far as 1880 [DX-1; DX-2; DX-5; DX-8; DX-19; DX-21; DX-22], show that each of the elements of the Adams battery was well known in the battery-making art at least 50 years before the Adams application for letters patent [R-167, 175, 178-81, 189-96, 636-37; PX-42, p. 2; See also Comm. Find. No. 15, *infra,* and annotations thereto]. Adams, after all these many disclosures, put together the specific *combination* of elements that resulted in a light-weight cell [R-155, 208-10, 322; TX-2, p. 1, col. 1, ls. 8-15; TX-6, p. 1, col. 1, ls. 4-11; TX-10, p. 1, col. 1, l. 10 and p. 2, col. 1, l.9; PX-18, pp. 2, 4, 8; PX-19, p. 2; PX-37, pp. 203C, 204C; TX-15, p. 3; CX-2, p. 23] which could be exposed to extreme temperature conditions [R-80-81; 155-56, 165, 208-10, 313; TX-10, p. 2, col. 1, ls. 11-12; TX-15, p. 2; R-96; CX-2, pp. 23, 70-2, 88-90; PX-16, p. 701; PX-18, pp. 1-3; R-163, [fol. 921] 324-25; TX-2, p. 1, col. 1, ls. 8-15; TX-6, p. 1, col, 1, ls. 3-11; PX-19, pp. 1-2] and which, upon activation by water, produced a constant electric potential [TX-10, p. 1, col. 1, ls. 3-4 and p. 2, col. 1, ls. 10-11; PX-18, p. 2; R-157-9, 315-6; TX-15, pp. 2-3, 15; R-327-28; TX-12, p. 12; PX-37, pp. 203C-204C; R-163-64, 325; TX-2, p. 1, col. 1, ls. 8-15; TX-6, p. 1, col. 1, ls. 4-11; PX-19, pp. 1, 4]. The volume of the prior art points to the novelty of the Adams invention [DX-1 thru DX-24]. It has been frequently held that voluminous prior art indicates that none of the prior art is in point or indicates that prior attempts to solve the problem have not

met with success. In the case of *Reynolds* v. *Whitin Mach. Works,* 167 F. 2d 78 (4th Cir. 1948), 76 U.S.P.Q. 551, it was held, at pages *83* and *84*:

> Defendant has cited 21 patents as basis for its contention that complainants' invention is lacking in novelty; and this in itself is evidence of the weakness of the contention. Such a citation of so many prior patents almost always means either that none of them is in point and that the patentee has brought together for the purpose of his invention devices to be found in prior patents of different character, or that there have been prior attempts to solve the problem with which he was confronted which have not met with success.

The fact that it was known to one skilled in the battery art that the various individual components of the Adams battery could be used in designing batteries [R-167, 175 178-81, 189-96, 449, 636-37; PX-42, p. 2; See also Comm. Find. No. 15, *infra,* and annotations thereto], does not make the Adams invention obvious and unpatentable within the meaning of 35 U.S.C. §103 [R-636-37, R-400-1]. The pertinent portion of this section reads as follows:

> A patent may not be obtained though the invention is not identically disclosed or described as set forth [fol. 922] in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

The evidence presented during the trial shows that although the necessary materials and techniques were available to the battery experts for over 50 years [R-636-7; PX-42; R-167, 175, 178-81, 189-96, 576-77, 620. See generally DX-1 thru DX-24], no one put them together [R-636-7, R-400-1, and Comm. Find. No. 15, *infra,* and annotations thereto], or recognized that the *combination* would work [PX-16, pp. 701-02; TX-12, pp. 11-12, R-309-13, 324-28, 398-401; PX-40, p. 1, col. 1, ls. 62-66; R-398-401; PX-41, p. 1, col. 2, ls. 15-16; R-399], or yield new and unex-

pected results [R-80-1, 85, 96, 156, 164-5, 210, 307-8, 309, 310-11, 313, 315-6, 327; PX-16, p. 701; PX-18, p. 2; PX-19, p. 1; PX-37, pp. 203C-204C; TX-10, p. 1, col. 1, ls. 2-14 and p. 2, col. 1, ls. 10-17; TX-12, pp. 11-12; TX-15, pp. 1-5, 15-16]. Further, the evidence shows that the invention constituted an important advance in the art [R-80-1, 85, 96, 156, 164-5, 210, 307-8, 309, 310-11, 313, 315-6, 327; PX-16, p. 701; PX-18, p. 2; PX-19, p. 1; PX-37, pp. 203C-204C; TX-10, p. 1, col. 1, ls. 2-14 and p. 2, col. 1, ls. 10-17; TX-12, pp. 11-12; TX-15, pp. 1-5, 15-16] and has had many successful uses [CX-2, pp. 23, 69, 88; PX-37, p. 203C; R-297; PX-20; PX-18, pp. 2, 4; R-315-6; PX-19, p. 1; R-165; R-639-40; PX-43; TX-15, pp. 2-3, 15-16, R-355-56, 357-58, 445-6; R-157-160, 393-5; R-639]. The courts have recognized that obviousness is negated where the patent teaches a solution which has long eluded the researchers in the art, even though all the elements required to provide the solution have been readily [fol. 923] available. In *Goodyear Co.* v. *Ray-O-Vac Co.*, 321 U.S. 275, 60 U.S.P.Q. (1944), in supporting the validity of a patent relating to a leakproof dry cell for a flashlight battery, Mr. Justice Roberts, writing for the Supreme Court, said, at page 279:

> Viewed after the event, the means Anthony adopted seem simple and such as should have been obvious to those who worked in the field, but this is not enough to negative invention. During a period of half a century, in which the use of flashlight batteries increased enormously, and the manufacturers of flashlight cells were conscious of the defects in them, no one devised a method of curing such defects. Once the method was discovered it commended itself to the public as evidenced by marked commercial success. These factors were entitled to weight in determining whether the improvement amounted to invention and should, in a close case, tip the scales in favor of patentability. Accepting, as we do, the findings below, we hold the patent valid and infringed.

See also *Peerless Equipment Co.*, v. *W. H. Miner, Inc.*, 93 F. 2d 98 (7th Cir., *1937*), 35 U.S.P.Q. 396, and *Remington Rand Business Service, Inc.* v. *Acme Card System Co.*, 71 F. 2d

628 (4th Cir., *1934*), 22 U.S.P.Q. 1. While the use of any of the individual components of the Adams battery cell may have been obvious at the time of the invention, the invention *as a whole* was not obvious, at the time the invention was made, to a person having ordinary skill in the art [R-604; R-636-7; R-400-1].

The fact that the Adams patent discloses only a single embodiment of his invention [TX-10; R-415; R-173-77] does not necessarily restrict the claims of his patent to that particular embodiment. The Adams patent discloses that the cuprous chloride electrode is made by heating cuprous chloride until it melts and then forming it into a cylindrical electrode by the use of a mold [TX-10, p. 1, col. 2, ls. 8-27, R-175-6]. The defendant alleges that since the cuprous chloride electrode is referred to in the speci- [fol. 924] fication and the claims as *fused*, the claims must be restricted to the type of electrode described in the specification of the patent. The facts show that the term fused may refer to unifying by means other than by the particular method described in the specification of the Adams patent [R-136, 170-71, 176-78, 196-7, 198, 214, 355, 411-13, 419-20, 458-9, 596-7, 609]. The description of an invention in the specification is required by 35 U.S.C. § 112, which reads in part as follows:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

It is evident that this section does not require an inventor to disclose every possible way in which his invention may be used, nor does it limit the claims of the patent to the particular mode which the inventor considers best at the time of filing his application for patent. In the case of *Smith* v. *Snow*, 294 U.S. 1, 24 U.S.P.Q. 26 (*1935*), Mr. Justice Stone, in discussing this point, said, at page *11:*

We may take it that, as the statute requires, the specifications just detailed show a way of using the inventor's method, and that he conceived that particular way described was the best one. But he is not confined to that particular mode of use since the claims of the patent, not its specifications, measure the invention.

It is clear that the Adams patent claims are not limited to covering only electrodes made in the specific manner described in the specification.

[fol. 925] The fact that in some instances silver chloride may be equivalent to cuprous chloride does not entitle the plaintiffs to extend the coverage of the Adams patent claims to cover silver chloride electrodes as well as cuprous chloride electrodes. Neither the specification nor the claims of the Adams patent mention that silver chloride may be used as the electronegative electrode [TX-10]. However, plaintiffs allege that silver chloride and cuprous chloride were well known electrochemical equivalents prior to the Adams invention, and that cells made with silver chloride electrodes also infringe the claims of the patent. The doctrine of equivalents is based on the theory that one should not be able to avoid infringement of a patent merely by substituting an equivalent for one of the elements recited in a claim. The doctrine is invoked when a person reasonably skilled in the art would have known of the interchangeability of an ingredient not disclosed in the patent with one that was. *Graver Mfg. Co.* v. *Linde Co.*, 339 U.S. 605, 85 U.S.P.Q. 328 *(1950)*. It cannot be said that one reasonably skilled in the battery art would have known of the interchangeability of cuprous chloride and silver chloride in the Adams battery. The battery disclosed in the Adams patent is made up of *particular* components which unexpectedly produced a battery having unique characteristics [R-80-1, 85, 96, 156, 164-5, 210, 307-8, 309, 310-11, 313, 315-6, 321; PX-16, p. 701; PX-18, p. 2; PX-19, p. 1; PX-37, pp. 203C-204C; TX-10, p. 1, col. 1, ls. 2-14 and p. 2, col. 1, ls. 10-17; TX-12, pp. 11-12; TX-15, pp. 1-5, 15-16]. The Adams patent specification is completely silent as to any other components which would work equally well in his battery [TX-10].

[fol. 926] The public was left to mere speculation or experimentation to determine whether in all the known battery components there was any other component which could be used in place of the particular components which Adams disclosed [TX-10]. In considering equivalency, the context of the patent, the prior art, and the particular circumstances of the case must also be weighed. In the present case, the validity of the Adams patent is sustained on the ground that, in a crowded art, Adams selected *specific* components from the group of known battery components and found that the *combination* of these specific components resulted in a workable battery having unique and unexpected characteristics [R-80-1, 85, 96, 156, 164-5, 210, 307-8, 309, 310-11, 313, 315-6, 327; PX-16, p. 701; PX-18, p. 2; PX-19, p. 1; PX-37, pp. 203C-204C; TX-10, p. 1, col. 1, ls. 2-14 and p. 2, col. 1, ls. 10-17; TX-12, pp. 11-12; TX-15, pp. 1-5, 15-16]. The unexpectedness of the Adams invention is evidenced by the fact that, even today, the theory upon which the Adams battery operates is unknown [PX-40, p. 1, col. 1, ls. 62-6; R-398-401; PX-41, p. 1, col. 2, ls. 15-16; R-399]. To allow the plaintiffs to expand the Adams patent claims to include other allegedly equivalent components, which were also in the known group of battery components at the time of the Adams invention, would be contrary to the finding of validity. It was stated in *Union Carbide & Carbon Corp.* v. *Graver Tank & Mfg. Co.*, 196 F. 2d 103, 112, 93 U.S.P.Q. 137 (7th Cir., *1952*), that:

> [fol. 927] In our opinion, the application of the doctrine of equivalency in this case is to ignore the teachings of the patent, the representation upon which the claims in suit were allowed and, more pointedly perhaps, the representations by which their validity has been sustained in the courts. While the difference between plaintiff's composition and those accused may not be great, it is that difference which distinguished plaintiff's composition from the prior art and which enabled it to sustain the validity of its grant. It is now estopped from claiming otherwise.

The fact that Adams submitted disclosures of his invention to the National Inventors Council [Stip. July 6, 1961, par. 1; TX-15, pp. 1-5; R-65-6; TX-12, p. 7, R-88; TX-15, pp.

13-18; R-88, TX-16, p. 4; R-84; TX-12, p. 8, R-89; TX-12, p. 9, R-90; TX-15, p. 19, R-99; TX-12, p. 15; TX-15, pp. 1-5, R-65-6; TX-17, pp. 10, 11, 15, R-99-100] and personnel of defendant's Signal Corps, and Navy [TX-17, p. 1, R-67-8; TX-15, pp. 6-11; R-67-8; TX-17, p. 8, Ref. (a), R-68; TX-16, p. 1, R-69, 75; TX-16, p. 2, R-70; R-72, TX-16, p. 3; R-76-7, 79; Stip. June 8, 1961, par. 7; PX-4, R-77-8; PX-9, R-105-6; TX-16, p. 7, R-106; TX-12, p. 1, R-79; TX-12, p. 6, par. 1; TX-16, p. 4, R-79-80, 82; Stip. June 8, 1961, par. 7; TX-17, p. 3, R-81-3; TX-17, p. 5, R-82-3; TX-17, p. 6; R-83-4; TX-15, p. 12, R-85-6; TX-17, p. 7, R-91; PX-14; R-92-3, 316; PX-5, 8, R-96; PX-17, PX-4, 5, R-101-2; PX-15, R-94; TX-16, pp. 5-6, R-95-8; TX-15, p. 19, R-98-100], coupled with the fact [fol. 928] that the defendant has used the Adams invention [R-317-8, TX-1, 7, 8 and 9; Stip. June 8, 1961, pars. 3 and 5; R-211-12, R-214-19, R-220-27, R-244; R-265; R-271; R-272-75; R-282-94; R-424-6, 577-8; PX-36], does not establish an express or implied contract between the plaintiffs and defendant. The plaintiffs allege that certain publications of the National Inventors Council [TX-13, Bulls. Nos. 1 and 2] contained general offers to the public to enter into a unilateral contract which could be accepted by disclosing inventions to the Council and become binding when a condition precedent, use of the invention by the defendant, was fulfilled. Plaintiffs also allege that the disclosure of the Adams battery to personnel of the Signal Corps and the Navy, coupled with the subsequent use of the invention by the defendant, establishes an implied contract [See above]. It is not believed that either of these contentions has been successfully made out. With regard to any contract with the National Inventors Council, the evidence does not support the contention that defendant's publications [TX-13] in fact contained offers to enter into a unilateral contract. Further, the evidence does not establish that either the National Inventors Council or the personnel of the Signal Corps or the Navy had authority to make such an offer or [fol. 929] enter into a binding contract on defendant's behalf. The facts alleged are not sufficient to prove the existence of a contract, express or implied, between defendant and plaintiffs. *James J. Gearon, et al.* v. *United States*, 126 Ct. Cl. 548, 99 U.S.P.Q. 286 (*1953*); *Frederick P. Fulmer* v. *United States*, 144 Ct. Cl. 812 (*1959*).

Claims 1 and 10 of the Adams patent have been specifically relied upon by the plaintiffs [R-211 *et seq.*]. These two patent claims, set forth in finding 12, each define a combination including a magnesium electropositive electrode and a fused cuprous chloride electronegative electrode [TX-10; R-211]. Claim 10 also recites the presence of a carbon catalytic agent in the electronegative electrode [TX-10; R-211]. The accused Eagle-Picher and Ray-O-Vac battery units identified in findings 25 and 26 as trial exhibits 7, 8, and 9, each include a magnesium electropositive electrode and a fused cuprous chloride electronegative electrode [R-214-25] as set forth in more detail in finding 34. These batteries infringe claim 1 of the Adams patent. The accused Burgess battery unit identified in findings 28 and 37 as trial [fol. 930] exhibit 18 contains a silver chloride electronegative electrode [R-3] and does not infringe the claims of the Adams patent.

Summarizing, it is found that plaintiffs are the rightful owners of the Adams patent, that the patent is valid, that the invention claimed therein has been used by defendant without license of the owners, that the plaintiffs are entitled to recover compensation for such use, and that the extent of liability should be determined in further proceedings pursuant to Rule 38 (c).

Findings of Fact

1. This is a suit involving a patent claim and a contract claim brought under the provisions of 28 U.S.C. §§ 1491 and 1498 and 22 U.S.C. §§ 1668 (repealed) and 1758 [Petition, pars. 1 and 2]. The parties have stipulated that this court has jurisdiction over all of the parties involved and over the issues raised by the petition and answer [Stip. June 8, 1961, par. 1].

2. The patent claim is for reasonable and entire compensation for unauthorized and infringing use or manufacture by or for defenant, and for the unauthorized and infringing use within the United States in furtherance of the purposes of the Mutual Security Acts of 1951 and 1954 of United States Letters Patent No. 2,322,210 entitled "Battery" which issued June 22, 1943, on an application for patent filed by Bert N. Adams, a plaintiff herein [Petition,

pars. 1 and 2]. This patent will be referred to hereinafter [fol. 931] as the Adams patent.

3. The breach of contract claim is for reasonable and entire compensation for defendant's breach of an express or implied contract existing between defendant and plaintiffs relating to compensation for use or manufacture by or for defendant of batteries made in accordance with disclosures made to defendant by plaintiff Bert N. Adams [Petition, par. 1].

4. At pretrial conference, the parties stipulated that upon proof of the manufacture by or for, or the use by or for, the defendant, of one or more articles alleged in the petition, or otherwise alleged on the record, to infringe the Adams patent, the issues of patent validity and of infringement of the patent by the defendant would be first determined upon full proofs, findings of fact, and argument of counsel [Stip. June 8, 1961, par. 2]. The parties further agreed that the accounting issue, including evidence as to the number of articles procured and/or the value of the patented invention, or the extent of the liability, if any, of the defendant, and the amount of reasonable and entire compensation, if any, due to plaintiffs on account thereof, would be deferred until after the entry of the order of the court on the issues of patent validity and/or patent infringement [Stip. June 8, 1961, par. 2].

5. The ownership of the Adams patent, the application therefor, and the claims against the defendant involved in this suit are as follows [Stip. July 6, 1961; TX-14]:

[fol. 932] a. The application for patent was filed December 18, 1941, and from that date through January 14, 1942, ownership of the application and any claims arising during this period was: 10 percent in Olaf Hallingby (owned until July 16, 1959, by his heirs, Mary Seimers, George Hallingby, Iris Petry, and Jane Maesel), and 90 percent in Bert N. Adams [Stip. July 6, 1961; TX-14].

b. From January 15, 1942, through January 16, 1942, ownership of the application and the claims arising during this period was: 10 percent in Olaf Hallingby (owned until July 16, 1959 by his heirs, Mary Seimers, George Hallingby, Iris Petry, and Jane Maesel); 45 percent in Bert N. Adams, and 45 percent in Emma Adams [Stip. July 6, 1961; TX-14].

c. From January 17, 1942, through September 14, 1942, ownership of the application and the patent (which issued on June 22, 1942) [Stip. July 6, 1961; TX-14] and the claims arising during this period was: 10 percent in Olaf Hallingby (owned until July 16, 1959, by his heirs, Mary Seimers, George Hallingby, Iris Petry and Jane Maesel); 45 percent in Emma Adams; 1.35 percent in Ernest Sutcliffe (owned by his heir, Helen Sutcliffe, until July 16, 1959), and 43.65 percent in Bert N. Adams [Stip. July 6, 1961; TX-14].

d. From September 14, 1942, through April 14, 1959, ownership of the application and the patent and the claims arising during this period was: 10 percent in Olaf Hallingby (owned until July 16, 1959, by his heirs, Mary Seimers, George Hallingby, Iris Petry, and Jane Maesel); 45 percent [fol. 933] in Emma Adams; 0.9 percent in Ernest Sutcliffe (owner by his heir, Helen Sutcliffe, until July 16, 1959), and 44.1 percent in Bert N. Adams [Stip. July 6, 1961; TX-14].

e. From April 15, 1959, through July 15, 1959, ownership of the patent and the claims arising during this period was: 10 percent in Olaf Hallingby (owned until July 16, 1959, by his heirs, Mary Seimers, George Hallingby, Iris Petry, and Jane Maesel); 0.9 percent in Ernest Sutcliffe (owned until July 16, 1959, by his heir, Helen Sutcliffe), and 89.1 percent in Bert N. Adams [Stip. July 6, 1961; TX-14.]

f. From July 16, 1959, through August 30, 1959, ownership of the patent and the claims arising during this period was 100 percent in Bert N. Adams [Stip. July 6, 1961; TX-14].

g. After August 31, 1959, ownership of the patent (which expired June 21, 1960) and the claims arising during this period was 100 percent in plaintiff Lewis M. Schott [Stip. July 6, 1961; TX-14].

6. Adams first became interested in batteries in the summer of 1939 [R-34]. While employed at the New York World's Fair, he studied various battery theories at home, and conducted experiments using various types of electrodes and electrolytes in batteries [R-33-6]. Finally, Adams discovered that when cuprous chloride was used in combination with magnesium and water, the result was an operable battery [R-35-6].

7. Adams continued experimenting [R-39-42], and in 1940, after accidentally dropping cigarette ashes into the [fol. 934] cuprous chloride which he was making into a cathode [R-39-41], he discovered that the addition of carbon improved the battery by increasing the current and providing a substantially level (constant) potential [R-41-2]. Subsequent experiments taught Adams that a small addition of magnesium chloride to the electrolyte would increase the speed of activation of the battery [R-47-8; PX-3] and that the addition of a small amount of magnesium sulphate helped to clean the electrodes [R-47-8; PX-3].

8. On December 18, 1941, Adams filed an application for patent in the United States Patent Office [TX-10]. This application resulted in the issuance of the Adams patent on June 22, 1943 [Stip. June 8, 1961, par. 6; TX-10; TX-11].

9. The Adams patent disclosed a battery comprised of a magnesium electropositive electrode (anode), a cuprous chloride electronegative electrode (cathode), and a water electrolyte [TX-10; R-211-3, 166-7]. The distinctive characteristics of this battery are that it is light in weight [R-155, 208-10, 322; TX-2, p. 1, col. 1, ls. 8-15; TX-6, p. 1, col. 1, ls. 4-11; TX-10, p. 1, col. 1, l. 10 and p. 2, col. 1, l. 9; PX-18, pp. 2, 4, 8; PX-19, p. 1; PX-37, pp. 203C, 204C; TX-15, p. 3; CX-2, p. 23], it uses ordinary water as an electrolyte [R-77-8; TX-10, col. 2, ls. 54-55; TX-15, p. 2, 15-16; PX-18, p. 2; CX-2, p. 23], it may be manufactured and distributed in a dry condition [R-152; TX-10, p. 1, col. 1, ls. 11-14; PX-16, p. 701; PX-20, R-158-63; TX-15, [fol. 935] pp. 2-3, 15; PX-19, p. 1] and may be rendered serviceable by merely filling the container with ordinary water [R-77-8; TX-10, col. 2, ls. 54-55; TX-15, p. 2, 15-16; PX-18, p. 2; CX-2, p. 23; R-152; TX-10, p. 1, col. 1, ls. 11-14; PX-16, p. 701; PX-20, R-158-63; TX-15, pp. 2-3, 15; PX-19, p. 1], it may be operated under extremely cold conditions ([R-80-81; R-155-56, 165, 208-10, 313; TX-10, p. 2, col. 1, ls. 11-12; TX-15, p. 2; R-96; CX-2, pp. 23, 70-72, 88-90; PX-16, p. 701; PX-18, pp. 1-3; R-163, 324-25; TX-2, p. 1, col. 1, ls. 8-15; TX-6, p. 1, col. 1, ls. 8-11; PX-19, pp. 1-2], and, upon complete activation, it produces a linear (constant) potential [TX-10, p. 1, col. 1, ls. 3-4 and p. 2, col. 1, ls. 10-11; PX-18, p. 2; R-157-9, 315-6; TX-15, pp. 2-3, 15; R-327-28; TX-12, p. 12; PX-37, pp. 203C-204C; R-163-64,

325; TX-2, p. 1, col. 1, ls. 8-15; TX-6, p. 1, col. 1, ls. 9-11; PX-19, pp. 1, 4] which continues until the battery is substantially exhausted [PX-18, p. 2; PX-37, p. 203C; R-157-9, 163; TX-15, pp. 2-3; PX-19, p. 1].

10. The Adams patent contains several illustrative drawings which are reproduced below.

[Drawings Omitted: See Original Opinion at p. 11].

[fol. 936] 11. The specification of the Adams patent describes the drawings in part as follows [TX-10, p. 1, col. 1, l. 16 to col. 2, l. 33]:

> Figure 1 is a sectional view of a battery in accordance with my invention;
>
> Figure 2 is a top plan view; and
>
> Figure 3 is a sectional view taken along the line 3-3 of Figure 1.
>
> In the embodiment selected for illustration, I make use of a container 10 provided with a closure or cover 12 of insulative material. The container 10 may comprise glass or any other material which is waterproof. Inside the container 10 is arranged an electro-positive electrode 14 comprising pure magnesium. The electro-positive electrode 14 is in the form of an open ended tube of a length slightly less than the height of the container 10. Projecting upwardly from the bottom 16 of the container are notched ears 18 in which the lower end of the electro-positive electrode 14 is supported. An extension 20 is provided at the upper end of the electro-positive electrode 14, which extension projects through an opening 22 in the cover 12 to constitute one terminal of the battery. The outer surface of the electro-positive electrode 14 is provided with a coating of tar 24.
>
> Arranged concentrically within the electro-positive electrode 14 is an electro-negative electrode 26 in the [fol. 937] form of a cylinder coextensive in length with the electro-positive electrode 14. Embedded in the upper end of the electro-negative electrode 26 is a copper terminal 28 extending through an opening 30

in the cover 12. The electronegative electrode 26 is of uniform diameter less than the inside diameter of the electropositive electrode 14 so as to provide a space 32 for the liquid contained in the battery. To the terminal 28 is connected one end of a copper coil 34 embedded in the core 36. The electropositive electrode 14 is of considerably smaller outside diameter than the inside diameter of the container 10 to provide a space 38 for the liquid, which space has communication with the space 32 at the bottom of the battery by reason of the ears 18 and also by reason of the fact that the electropositive electrode terminates short of the cover 12.

The body 36 of the electronegative electrode 26 comprises fused cuprous chloride (CuCL). In manufacturing the body 36, the coil 34 and the terminal 28 are arranged in a mold and the latter supplied with the requisite amount of cuprous chloride poured from a heated crucible. A piece of wood carbon is placed on the top of the cuprous chloride in the crucible and the latter is heated to a temperature ranging between 400° and 500° centigrade at which the cuprous chloride may be poured. The wood carbon constitutes a catalytic agent which renders the electronegative electrode 26 successful for the purpose intended, the exact chemical [fol. 938] action being unknown to me.

After the electronegative electrode 36 is removed from the crucible, it is cooled and dipped in a 66° Baume solution of sulphuric acid. While still dripping wet, the electrode 26 is covered with aluminium powder to prevent oxidation thereof. The electrode 26 is now ready for use.

The lower end of the electrode 26 is rested on a wood block 40 on the bottom 16. Both terminals 20 and 28 are firmly anchored in the cover 12 so that all the parts are maintained in fixed relationship when assembled with the container.

12. Although all 11 claims of the Adams patent are in suit, plaintiffs have relied specifically on claims 1 and 10. The elements of these two claims are as follows:

Patent Claim 1

A battery comprising

a liquid container,
a magnesium electropositive electrode
inside the container
and having an exterior terminal,
a fused cuprous chloride electronegative electrode, and
a terminal connected with said electronegative electrode [TX-10, p. 2, col. 1, ls. 23-28].

[fol. 939]

Patent Claim 10

In a battery, the combination of

a magnesium electropositive electrode, and an electronegative electrode comprising cuprous chloride fused with a carbon catalytic agent [TX-10, p. 2, col. 2, ls. 42-45].

Validity Issue

13. Defendant urges that the patent is invalid on the grounds that the invention was fully anticipated by the prior art and is hence invalid under 35 U.S.C. §§ 101 and 102, and that the invention was obvious to those skilled in the art at the time that it was made, and is hence invalid under 35 U.S.C. §§ 103.

14. Defendant has cited 24 prior patents and publications, defendant's exhibits 1-24, identified as follows:

Elementary Treatise on Electric Batteries, Niaudet, 1880, pages ix, 200-209 [DX-1];
Hayes patent 282,634, 1883 [DX-2];
Galvanic Batteries, Bottone, 1902, pages 172-177 [DX-3];
Primary Batteries, Carhart, 1891, pages 62-65 [DX-4];
Barrett patent 405,196, 1889 [DX-5];
Hard patent 457,116, 1891 [DX-6];
Hathaway patent 454,598, 1891 [DX-7];

Van Tenac patent 184,932, 1876 [DX-8];
[fol. 940] Fink patent 434,593, 1890 [DX-i];
Pearson patent 512,055, 1894 [DX-10];
Practical Primary Cells, Codd, 1929, pages 1-3, 43, 44, 78-81, 110, 117 [DX-11];
Wood patent 1,696,873, 1928 [DX-12];
Ruben patent 1,920,151, 1933 [DX-13];
Jumau patent 2,078,143, 1937 [DX-14];
Manual of Chemistry, Simon, 1905, page 216 [DX-15];
Essentials of General Chemistry, Hopkins, 1946, pages 371, 372, period table [DX-16];
Ferrabino British patent 301,923, 1928 [DX-17];
Thurnauer, et al. patent 552,211, 1895 [DX-18];
Skrivanoff British patent 4,341 of 1880 [DX-19];
Wensky British patent 49 of 1891 [DX-20];
Copper-Zinc and Copper-Tin Alloys, Laurie, 1888, pages 104-116 [DX-21];
Parkhurst patent 269,454, 1882 [DX-22];
Heil patent 653,770, 1900 [DX-23];
Harrison patent 1,522,121, 1925 [DX-24].

15. Nine of these publications disclose batteries utilizing silver chloride [DX-2 thru DX-10 inclusive]; none of these items disclose the use of magnesium [DX-2 thru DX-10 inclusive]. Four of these publications disclose batteries with magnesium as a component [DX-12, 13, 14 and 17]; none of these disclose the use of silver or cuprous chloride [DX-12, 13, 14 and 17]. Three of these publications disclose the [fol. 941] use of cuprous chloride as a single component [DX-18, 20 and 21], none of these disclose its use in conjuction with magnesium [DX-18, 20 and 21]. Two of these publications disclose the use of neither magnesium, nor cuprous chloride, nor silver chloride [DX-22 and 23]. A total of 18 of defendant's 24 cited publications disclose either none of the components of the Adams system or at most one single component of the system [DX-2 thru DX-10 and DX-12, 13, 14, 17, 18, 20, 21, 22 and 23]; none of these 18 items disclose the combination of even two of the components [DX-2 thru DX-10 and DX-12, 13, 14, 17, 18, 20, 21, 22 and 23]. Only three of defendant's anticipatory references disclose more than one component of the Adams system [DX-1, 11 and 19].

16. The Codd textbook [DX-11] (on page 22)* mentions magnesium but only for use in a cell in which the other electrode is copper and the electrolyte is dilute sulfuric acid [DX-11, p. 2]. On page 44, in discussing another battery entirely, Codd discusses silver chloride as an electrode [DX-11, p. 44]. There is no suggestion in Codd that the materials could be combined in a battery [DX-11].

17. The Skrivanoff foreign patent [DX-19] discloses a battery having an electrode of magnesium, an electrode comprising cuprous chloride *mixed together with* some seven other substances, and a strong electrolyte [DX-19, p. 2, ls. 31-43, ls. 49-51 and p. 3, ls. 26-28]. The evidence establishes that the disclosure of this very old patent is inoperative [R-646].

[fol. 942] 18. The Niaudet treatise [DX-1] (1880) discloses a battery having an electrode of silver chloride, an electrode of zinc, and plain water as an electrolyte [DX-1, p. 201; R-181-7]. This disclosure contains no suggestion that magnesium might be substituted for zinc in this battery [DX-1].

19. The Harrison patent [DX-24], cited by defendant to show the state of the art [R-629], discloses a battery in which the electrodes are immersed in sea water on opposite sides of a ship [DX-24, p. 4, col. 1, ls. 39-41]. One electrode is magnesium and the other is copper [DX-24, p. 4, col. 1, ls. 19-41]. The electrolyte is the sea water [DX-24, p. 1, col. 1, ls. 39-49]. The patent explains that because of exposure to sea water, the potential characteristics and current yield for a copper electrode having a given area will gradually improve [DX-24, p. 3, col. 1, ls. 4-15].

20. The Simon article [DX-15] and the Hopkins article [DX-16], which were not cited by the defendant as anticipatory references [R-605-6], show that magnesium is an alkaline earth metal [DX-15, p, 261; DX-16, p. 372 and table]. The Jumau patent [DX-14] discloses that the electrolyte in a lead chloride-magnesium battery may be a dilute solution of an alkaline earth salt, such as a sulphate or a chloride [DX-14, p. 1, col. 2, ls. 12-18].

21. Summarizing findings 14 through 20, the cited publi-

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*See DX-11, p.2

cations and patents do not anticipate the invention defined in the several claims of the Adams patent.

22. Each of the elements of the several claims of the [fol. 943] Adams patent was individually old in the battery-making art at the time of the filing of the Adams application for the patent here in suit [PX-42, p. 2; R-167, 175, 178-81, 189-96, 449, 636-7; see generally, DX-1 thru DX-24]. While there is evidence of a definite need for a battery having the characteristics of the Adams battery [R-157-9, 165, 296-7, 315-6, 355, 369, 393-4, 445-6, 639; CX-2, pp. 23, 88-90; PX-18, pp. 2, 4; PX-37, p. 202C; PX-20; PX-19], those skilled in the art failed to develop one for a period of over 50 years [R-636-7], during which time all of the necessary ingredients were available [R-636-7; PX-42; R-167, 169, 175, 178-181, 189-96, 576-77, 620. See generally DX-1 thru DX-24]. There is no evidence that anyone had ever before suggested the specific *combination* of elements which make up the Adams battery [See Comm. Find. Nos. 14 and 15 and annotations thereto.] nor that anyone had ever before suggested that such a battery would have a substantially constant potential, could be operated under extreme temperatures and could be operated with ordinary or distilled water [See Comm. Find. No. 23 and annotations thereto.]

23. The Adams invention was the first practical, water-activated, constant potential battery capable of operation at low temperatures [R-77-8; TX-10, col. 2, ls. 54-55; TX-15, pp. 2, 15-16; PX-18, p. 2; CX-2, p. 23; R-80-81; R-155-56, 165, 208-10, 313; TX-10, p. 2. col. 1, ls. 11-12; TX-15, p, 2; R-96; CX-2, pp. 23, 70-72, 88-90; PX-16, p. 701; PX-18, pp. 1-3; R-163, 324-25; TX-2, p. 1, col. 1, ls. 8-15; TX-6, p. 1, [fol. 944] col. 1, ls. 3-11; PX-19, pp. 1-2; TX-10, p. 1, col. 1, ls. 3-4 and p. 2, col. 1, ls. 10-11; PX-18, p. 2; R-157-9, 315-6; TX-15, pp. 2-3, 15; R-327-28; TX-12, p. 12; PX-37, pp. 203C-204C; R-163-64, 325; TX-2, p. 1, col. 1, ls. 8-15; TX-6, p. 1, col. 1, ls. 4-11; PX-19, pp. 1, 4]. When Adams first disclosed his invention to others skilled in the art, he did not know its theory of operation [R-398-401; R-39-41] and it was received with considerable skepticism [PX-16, pp. 701-02; TX-12, pp. 11-12; R-309-13, 324-28, 398-401]. However, this development was subsequently recognized throughout the industry as an extremely important step in rounding out the sources of battery-furnished power, and filling important,

long-standing needs of both civilian and military natures [R-639, 355-56, 357-58, 445-6; R-393-5; CX-2, pp. 23, 69, 88; PX-37, p. 203C; R-297; PX-20; R-157-60, 315-6; PX-19, p. 1; PX-18, p. 2; R-165].

24. Summarizing findings 22 and 23, the Adams invention was not, as a whole, obvious, at the time the invention was made, to a person having ordinary skill in the battery art.

INFRINGEMENT ISSUES

25. Plaintiffs contend that batteries embodying the invention and infringing the claims of the Adams patent were used or manufactured by or for defendant without authorization or license of plaintiffs. The parties have stipulated that the batteries identified as trial exhibits 7, 8 and 9 were procured by and delivered to the defendant within the 6-year period preceding the filing of the petition [fol. 945] [Stip. June 8, 1961, par. 5]. The parties further stipulated that articles made as described in trial exhibit 1 were procured by and delivered to the defendant within the 6-year period preceding the filing of the petition [Stip. June 8, 1961, par. 3].

26. Trial exhibit 7 is an Eagle-Picher battery unit designated BA-259/A M. Trial exhibit 8 is a Ray-O-Vac battery unit designated BA-292/A M. Trial exhibit 9 is a Ray-O-Vac battery unit designated BA-253/U.

27. Trial exhibit 1 includes a letter [TX-1, p. 10] from The Electric Storage Battery Company, stating that they have supplied to the defendant batteries having cuprous chloride plates made in accordance with United States Letters Patent Nos. 2,640,090 [TX-3], 2,640,091 [TX-4], and 2,667,527 [TX-5]. These three patents issued on applications filed after the Adams patent issued [TX-3, 4 and 5]. Trial exhibit 1 also includes a letter from Burgess Battery Company stating that the batteries produced by Burgess had a plate made of a paste of cuprous chloride, plastic binder, and graphite [TX-1, p. 15]. Trial exhibit 1 also includes a letter from The Eagle-Picher Company stating that all the magnesium cuprous chloride batteries which have been produced by Eagle-Picher have been made in accordance with the process outlined in United States Letters Patent No. 2,636,060 [TX-2] and/or Reissue No. 23,883

[TX-6]. These two patents issued to the defendant, as represented by the Secretary of the Army, on applications [fol. 946] filed after the Adams patent issued [TX-2; TX-6]. Trial exhibit 1 also includes a letter from Ray-O-Vac Company [TX-1, p. 6] stating that all of the batteries furnished to the defendant by Ray-O-Vac have had positive plates made in accordance with the process outlined in Patent No. 2,636,060 or Reissue No. 23,883, noted above, by a process involving subjecting a mixture containing cuprous chloride to pressure in a tableting machine to form pellets [TX-2; R-273; TX-6; R-272].

28. Trial exhibit 18, a Burgess battery unit designated X10183 is a water-activated, magnesium and silver chloride battery [R-3] introduced by defendant as illustrative of procurement of such devices during the 6-year period next preceding the filing of the petition [Memorandum of Pre-trial Conf., par. 3].

29. Patent Nos. 2,640,090 [TX-3], 2,640,091 [TX-4], and 2,667,527 [TX-5], which are referred to in finding 27, teach a water-activated, magnesium and cuprous chloride battery having a pasted grid type cuprous chloride plate made by mixing cuprous chloride with silver chloride and water, and pasting the mixture on a copper wire screen [R-274-6; R-291].

30. Patent No. 2,636,060, referred to in finding 27, teaches a process for making cuprous chloride electrodes for water-activated, magnesium, cuprous chloride batteries. The cuprous chloride electrodes are made by making a pasty mixture of cuprous chloride and water and pasting the mixture on wire screens [R-265]. Patent Reissue No. 23,883 [TX-6], referred to in finding 27, teaches a process for [fol. 947] making cuprous chloride electrodes for water-activated, magnesium, cuprous chloride batteries. The cuprous chloride electrodes are made by making a paste of cuprous chloride, a highly polymeric substance and an organic solvent, and pasting the mixture on wire screens [R-265].

31. Cuprous chloride is available commercially as a powder [R-167; PX-21]. To function as an electrode, the powder must be formed by some means into electrode shape [R-167, 179]. There are several methods of forming cuprous chloride into electrode shape [R-168-71]. On method, which

is suggested in the Adams patent, is to place the cuprous chloride in a crucible and heat the crucible until the cuprous chloride is pourable. Then the cuprous chloride is poured into a mold where it is allowed to solidify [TX-10, p. 11, col. 2, ls. 6-27; R-170, 175-77]. This "candlestick" method was known prior to 1880 [R-178-182]. Another method is to add water to cuprous chloride to form a pourable slurry, which, upon drying, hardens into a unified mass [R-169]. Still another method is to add toluene to cuprous chloride to form a pourable slurry which, upon drying, hardens into a unified mass [R-170-71].

32. Defendant alleges that by the use of the term *fused* cuprous chloride in the claims the Adams patent is limited to batteries using cuprous chloride electrodes made by the *heat* method. The method of forming the cathode makes no substantial difference in the electrochemical properties of cuprous chloride, whether the method be liquidification by [fol. 948] heat, water, or organic material, such as benzene or toluene [R-196-8; R-169, 170, 171]. There was considerable testimony at the trial both directly and indirectly relating to the term *fused*. Viewing this testimony as a whole, it appears that the term *fused* is used by some people as meaning unified only by heat. This limitation is by no means universally accepted and other people use the term as meaning unified by any one of a number of methods [R-136, 170-71, 176-78, 196-8, 214, 355, 411-13, 419-20, 458-9, 596-7, 609]. One of the definitions given for *fuse* in *Webster's New International Dictionary* (1934 Edition, page 1022, reads: "To unite or blend, as if melted together." The term *fused* as used in the claims of the Adams patent is found to encompass unification or uniting by various methods and is not limited to unification or uniting by heat.

33. Each of Patent Nos. 2,640,090 [TX-3], 2,640,091 [TX-4], 2,667,527 [TX-5], 2,636,060 [TX-2], and Reissue No. 23,883 [TX-6] teaches a unified cuprous chloride electrode which is *fused* within the meaning of the term as used in the Adams patent and claims.

34. Each of trial exhibits 7, 8 and 9 is a pile-type battery. They each have bibulous material which acts as a liquid container, a magnesium electropositive electrode inside the container having an exterior terminal, a fused cuprous elec-

tronegative electrode, and a terminal connected with said electronegative electrode [R-214-25].

35. The evidence is inconclusive and insufficient to deter- [fol. 949] mine whether there is carbon in the electronegative electrodes of trial exhibits 7, 8, and 9 [R-219-20, 223, 225], as required by the recital of Adams claim 10. However, since each of these exhibits contains each of the elements of claim 1 [See Comm. Find. Nos. 26, 27, 29, 30, 33, 34 and annotations thereto and also R-194-6, 214-25], it is unnecessary to pass upon this question.

36. The cuprous chloride plates manufactured by The Electric Storage Battery Company, Burgess Battery Company, The Eagle-Picher Company, and Ray-O-Vac Company, as described in trial exhibit 1, are *fused* within the meaning of the term as used in the Adams claims [See Comm. Find. Nos. 26, 27, 29, 30, 33, 34 and annotations thereto and also R-424-6, 577-8].

37. Trial exhibit 18 is a Burgess battery, which includes a liquid container, a magnesium electropositive electrode inside the container having an exterior terminal, a fused silver chloride electronegative electrode, and a terminal connected with said electronegative electrode. It does not have a cuprous chloride electrode [R-3].

38. Summarizing findings 25 through 37, claim 1 of the Adams patent has been infringed by trial exhibits 7, 8 and 9. Further, the cuprous chloride plates manufactured by The Electric Storage Battery Company, Burgess Battery Company, The Eagle-Picher Company, and Ray-O-Vac Company, as described in trial exhibit 1, would infringe claims in the Adams patent if used in a battery otherwise covered by the Adams claims. Trial exhibit 18 does not infringe claims of the Adams patent.

[fol. 950] CONTRACT ISSUE

39. The plaintiffs allege that defendant, through its National Inventors Council, made a general offer of a unilateral contract for acceptance by any member of the public by submission of a useful suggestion, with use by the defendant as a condition precedent to liability of defendant. Further the plaintiffs allege that Adams accepted the offer by sending disclosures of his invention to the defendant, and that

the condition precedent to defendant's liability has been fulfilled by defendant's use of the invention.

40. It is found that on January 7, 1942, Adams disclosed his invention to the National Inventors Council [Stip. July 6, 1961, par. 1; TX-15, pp. 1-5, R-65-6]; that on January 10, 1942, Adams disclosed his invention to The Chief Signal Officer of the U.S. Army [R-67-8; TX-15, pp. 6-11], and that on January 8, 1942, Adams disclosed his invention to the Navy Department [R-66-8; TX-17, p. 1]. The National Inventors Council replied, asking Adams for more information [TX-12, p. 7], which Adams then supplied [R-88; TX-15, pp. 13-18]. Subsequently, Adams informed the National Inventors Council that he was about to receive a patent on the battery [TX-15, p. 19], and through the Council he was able to obtain a priority for purchasing magnesium [TX-12, p. 15; R-100; TX-15, p. 20; TX-17, p. 10; TX-17, p. 11]. Both the Signal Corps [TX-12, p. 3; Stip. June 8, 1961, par. 12; TX-17, p. 15; R-99-101] and the Navy [R-68; TX-17, p. 8 [fol. 951] Ref.(a)] showed immediate interest in the disclosure, and Adams made trips to both Washington, D. C. [R-69-72; TX-16, p. 1], and Fort Monmouth, New Jersey [R-70-5; TX-16, pp. 1-2; R-76-7, 79, Stip. June 8, 1961, par. 7], where he turned over samples of his battery and made a complete disclosure of his intention to various representatives of the two branches [R-72, 76-7, 79; Stip. June 8, 1961, par. 7]. Subsequently, Adams was in further contact with the personnel at Fort Monmouth and delivered or sent additional information and samples for testing to Fort Monmouth at no expense to the Goxernment [TX-12, p. 1, R-79; TX-12, p. 6, par. 1, and p. 7; TX-17, p. 3, R-81; TX-17, p. 5, R-82-3; TX-17, p. 6, R-83-4; TX-16, p. 4, PX-6, R-80, 83-5, Stip. June 8, 1961, par. 7; Stip. July 6, 1961; TX-15, p. 12, R-85-6; TX-15, pp. 13-18, R-88-9; TX-12, p. 8, R-89-90; TX-12, p. 9, R-90; TX-17, p. 7, R-91; R-92-3; PX-14, R-92-3, 101-02, 316; R-96; PX-17, R-108-09; PX-15, R-94; TX-16, pp. 5-6, R-95-8; R-103; TX-15, p. 19, R-98-9; TX-12, p. 15; R-100; TX-15, p. 20; TX-17, pp. 10, 11 and 15; PX-9, R-55-6, 105-6; TX-16, p. 7; TX-17, p. 4; R-107-8]. Both the Navy and the Signal Corps finally concluded that the cell offered great promise [CX-2, p. 23, R-386-91; TX-12, p. 34, R-335, 341-2; TX-12, p. 67, R-328-32, 338; CX-4, Naval Research Laboratory Report of Nov. 1945, pp. 2-3, pars. 7, 8, R-353;

PX-16, p. 701, R-319-21; Cf. also the last annotation to Comm. Find. No. 23 regarding the widespread civilian and military use of Adams' invention.]

41. The National Inventors Council issued two docu- [fol. 952] ments which were available to Adams. The first document was Information Bulletin No. 1—Revised, dated March 1941, and contained, *inter alia*, the following statements:

> The submission to the National Inventors Council, under the provisions contained herein, of any description, drawing or other data pertaining to an invention is solely for the purpose of determining its military or naval value. Its acceptance by the Council does not legally obligate the United States Government or act as an estoppel under the patent statutes.
>
> * * * * * * *
>
> The Council has no authority to consider the question of compensation for the use of a suggestion or invention by any Government Department or agency. Should an invention be utilized, the matter of compensation will be referred to the Executive Department of the Government making use of the product embodying the invention. Final settlement for the acquirement of rights can then be arranged between the inventor and the appropriate official of the Department making the purchase.
>
> The amount of compensation can be considered only after tender of the suggestion or invention, and its adoption by an executive branch of the Government. The creation of the Council does not in any way affect the existing laws or practices of the Government Departments as to compensation [TX-13, Information Bull. No. 1, pars. 6, 9].

The second document was Information Bulletin No. 2—Revised 1942, and contained, *inter alia*, the following statement:

> * * * In such event, the appropriate departments of the Army and Navy then deal directly with the inventor in making the necessary arrangements for the use of the

invention. The Council itself does not consider the question of compensation or contracts between inventors and the Army or Navy. The negotiation of such contracts is conducted by the appropriate Military and Naval authorities [TX-13, Information Bull. No. 2, pp. 2-3].

[fol. 953] 42. In view of the statements quoted in the previous finding, it is found that the two documents from the National Inventors Council did not constitute an offer to enter into a binding contract. Additionally, the evidence does not warrant a finding that the National Inventors Council, or any of their personnel with whom Adams was in contact, had authority to enter into a binding contract on behalf of defendant.

43. Summarizing findings 39 through 42, it is found that the evidence has not established a contract, either express or implied, between the plaintiffs and the defendant regarding the Adams invention.

Upon the foregoing findings of fact, which are made a part of the judgment herein, the court concludes as a matter of law that United States Letters Patent 2,322,210 is valid; that the invention covered by said patent was used by defendant without authorization of the patent owners, and that plaintiffs are entitled to recover reasonable and entire compensation for such unauthorized use, and judgment will be entered to that effect. The extent of liability will be determined in further proceedings before a trial commissioner, pursuant to Rule 38(c).

Respectfully submitted, Donald E. Lane, Commissioner.

[fol. 954] [File endorsement omitted]

IN THE UNITED STATES COURT OF CLAIMS

No. 163-60

BERT N. ADAMS, EMMA ADAMS, GEORGE HALLINGBY (individually and as Executor of the Estate of Olaf Hallingby, deceased), JANE MAESEL, IRIS PETRY, LEWIS M. SCHOTT, MARY ELLEN HALLINGBY SEIMERS, and HELEN LOUISE SUTCLIFFE (individually and as Executrix of the Estate of Ernest M. Sutcliffe, deceased)

v.

THE UNITED STATES

John A. Reilly for plaintiffs. *Richard A. Huettner, William J. Ungvarsky* and *Kenyon & Kenyon* were on the brief. *Paul F. Arseneau,* with whom was *Assistant Attorney General John W. Douglas,* for defendant.

Before JONES, *Chief Judge,* WHITAKER, LARAMORE, DURFEE, and DAVIS, *Judges.*

OPINION—Decided April 17, 1964

PER CURIAM: This case was referred to Trial Commissioner Donald E. Lane, pursuant to Rule 45(a),[1] to make findings of fact and recommendation for conclusions of law. The commissioner has done so in a report filed January 28, 1963. Both plaintiffs and defendant have filed exceptions to the commissioner's report and briefs in support thereof. [fol. 955] The case was submitted to the court, an oral argument of counsel, on the issue of liability. The court agrees with, and adopts, the findings and recommendation of the commissioner, with a slight modification,[2] as the basis

[1] Now Rule 57(a).

[2] Since we hold that the Government has used plaintiffs' valid patent without authorization, we find it unnecessary to decide the issue of breach of an alleged implied contract to compensate plaintiffs for use of the invention because the

for its judgment in the case. Plaintiffs' patent is valid and the invention covered therein was used by defendant without authorization. Plaintiffs are entitled to recover reasonable and entire compensation for such unauthorized use, and judgment will be entered to that effect. The extent of liability will be determined in further proceedings before a trial commissioner, pursuant to Rule 47(c)(2).

OPINION OF COMMISSIONER

This is a claim for compensation under 28 U.S.C. § 1498, for unlicensed use of a patented invention, for compensation under 28 U.S.C. § 1491 for breach of implied contract, and for compensation under the Mutual Security Acts of 1951 and 1954, 22 U.S.C. §§ 1668 (repealed in 1954) and 1758, respectively.

The subject matter concerns an electric battery disclosed in United States Letters Patent 2,322,210, issued June 22, 1943, to Bert N. Adams, one of the petitioners herein. The patent disclosure, patent claims in suit, and the accused batteries used by defendant are described in the accompanying findings of fact. The several issues of law involved are discussed in the following comments.

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amount of recovery would not be changed by a decision on that issue. The amount of recovery under plaintiffs' contract claim would not be greater than that under the patent infringement claim: under plaintiffs' theory, the period for which contract recovery may be had is from 6 years prior to the filing of the present suit to date (Plaintiffs' Reply Brief, page 146); and the measure of recovery under the contract theory would be a reasonable royalty as compensation, *McKeever* v. *United States,* 14 Ct. Cl. 396, 425-426 (1878), which is substantially the same as the reasonable and entire compensation in infringement actions under 28 U.S.C. § 1498.

In this regard it is of interest to note our recent decision in *Padbloc Company* v. *United States,* Ct. Cl. No. 523-57, decided April 5, 1963, in which we found an implied contract and so it was unnecessary to decide the patent infringement issue.

One of the important issues raised by the pleadings is whether the fact that the individual constituents of the Adams battery have been long known in the art and have [fol. 956] been used in various combinations in numerous batteries developed in the past, negates the essential element of novelty required in a valid patent, even though the specific combination used by Adams was never before disclosed and produced unusual and unexpected results. The defendant has cited some 24 prior disclosures against the Adams patent. These citations, some of which date back as far as 1880, show that each of the elements of the Adams battery was well known in the battery-making art at least 50 years before the Adams application for letters patent. Adams, after all these many disclosures, put together the specific *combination* of elements that resulted in a lightweight cell which could be exposed to extreme temperature conditions and which, upon activation by water, produced a constant electric potential. The volume of the prior art points to the novelty of the Adams invention. It has been frequently held that voluminous prior art indicates that none of the prior art is in point or indicates that prior attempts to solve the problem have not met with success. In the case of *Reynolds* v. *Whitin Mach. Works*, 167 F. 2d 78 (4th Cir., 1948, 76 U.S.P.Q. 551, it was held, at pages 83 and 84:

> Defendant has cited 21 patents as basis for its contention that complainants' invention is lacking in novelty; and this in itself is evidence of the weakness of the contention. Such a citation of so many prior patents almost always means either that none of them is in point and that the patentee has brought together for the purpose of his invention devices to be found in prior patents of different character, or that there have been prior attempts to solve the problem with which he was confronted which have not met with success.

The fact that it was known to one skilled in the battery art that the various individual components of the Adams battery could be used in designing batteries, does not make

the Adams invention obvious and unpatentable within the meaning of 35 U.S.C. § 103. The pertinent portion of this section reads as follows:

> A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would [fol. 957] have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

The evidence presented during the trial shows that although the necessary materials and techniques were available to the battery experts for over 50 years, no one put them together, or recognized that the *combination* would work, or yield new and unexpected results. Further, the evidence shows that the invention constituted an important advance in the art and has had many successful uses. The courts have recognized that obviousness is negated where the patent teaches a solution which has long eluded the researchers in the art, even though all the elements required to provide the solution have been readily available. In *Goodyear Co.* v. *Ray-O-Vac Co.*, 321 U.S. 275, 60 U.S.P.Q. 386 (1944), in supporting the validity of a patent relating to a leakproof dry cell for a flashlight battery, Mr. Justice Roberts, writing for the Supreme Court, said, at page 279:

> Viewed after the event, the means Anthony adopted seem simple and such as should have been obvious to those who worked in the field, but this is not enough to negative invention. During a period of half a century, in which the use of flashlight batteries increased enormously, and the manufacturers of flashlight cells were conscious of the defects in them, no one devised a method of curing such defects. Once the method was discovered it commended itself to the public as evidenced by marked commercial success. These factors were entitled to weight in determining whether the improvement amounted to invention and should, in a close case, tip the scales in favor of patentability.

Accepting, as we do, the findings below, we hold the patent valid and infringed.

See also *Peerless Equipment Co.*, v. *W. H. Miner, Inc.*, 93 F. 2d 98 (7th Cir., 1937), 35 U.S.P.Q. 396, and *Remington Rand Business Service, Inc.* v. *Acme Card System Co.*, 71 F. 2d 623 (4th Cir., 1934), 22 U.S.P.Q. 1. While the use of any of the individual components of the Adams battery cell may have been obvious at the time of the invention, the invention *as a whole* was not obvious, at the time the invention was made, to a person having ordinary skill in the art.

The fact that the Adams patent discloses only a single [fol. 958] embodiment of his invention does not necessarily restrict the claims of his patent to that particular embodiment. The Adams patent discloses that the cuprous chloride electrode is made by hearing cuprous chloride until it melts and then forming it into a cylindrical electrode by the use of a mold. The defendant alleges that since the cuprous chloride electrode is referred to in the specification and the claims as *fused*, the claims must be restricted to the type of electrode described in the specification of the patent. The facts show that the term *fused* may refer to unifying by means other than by the particular method described in the specification of the Adams patent. The description of an invention in the specification is required by 35 U.S.C. § 112, which reads in part as follows:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

It is evident that this section does not require an inventor to disclose every possible way in which his invention may be used, nor does it limit the claims of the patent to the particular mode which the inventor considers best at the time of filing his application for patent. In the case of *Smith* v.

Snow, 294 U.S. 1, 24 U.S.P.Q. 26 (1935), Mr. Justice Stone, in discussing this point, said, at page *11:*

> We may take it that, as the statute requires, the specifications just detailed show a way of using the inventor's method, and that he conceived that particular way described was the best one. But he is not confined to that particular mode of use since the claims of the patent, not its specifications, measure the invention.

It is clear that the Adams patent claims are not limited to covering only electrodes made in the specific manner described in the specification.

The fact that in some instances silver chloride may be equivalent to cuprous chloride does not entitle the plaintiffs to extend the coverage of the Adams patent claims to cover [fol. 959] silver chloride electrodes as well as cuprous chloride electrodes. Neither the specification nor the claims of the Adams patent mention that silver chloride may be used as the electronegative electrode. However, plaintiffs allege that silver chloride and cuprous chloride were well known electrochemical equivalents prior to the Adams invention, and that cells made with silver chloride electrodes also infringe the claims of the patent. The doctrine of equivalents is based on the theory that one should not be able to avoid infringement of a patent merely by substituting an equivalent for one of the elements recited in a claim. The doctrine is invoked when a person reasonably skilled in the art would have known of the interchangeability of an ingredient not disclosed in the patent with one that was. *Graver Mfg. Co.* v. *Linde Co.*, 339 U.S. 605, 85 U.S.P.Q. 328 (1950). It cannot be said that one reasonably skilled in the battery art would have known of the interchangeability of cuprous chloride and silver chloride in the Adams battery. The battery disclosed in the Adams patent is made up of *particular* components which unexpectedly produced a battery having unique characteristics. The Adams patent specification is completely silent as to any other components which would work equally well in his battery. The public was left to mere speculation or experimentation to determine whether in all the known battery components there was any other component which could be used in place of

the particular components which Adams disclosed. In considering equivalency, the context of the patent, the prior art, and the particular circumstances of the case must also be weighed. In the present case, the validity of the Adams patent is sustained on the ground that, in a crowded art, Adams selected *specific* components from the group of known battery components and found that the *combination* of these specific components resulted in a workable battery having unique and unexpected characteristics. The unexpectedness of the Adams invention is evidenced by the fact that, even today, the theory upon which the Adams battery operates is unknown. To allow the plaintiffs to expand the Adams patent claims to include other allegedly equivalent components, which were also in the known group of battery components at the time of the Adams invention, would be contrary to the finding of validity. It was stated in *Union* [fol. 960] *Carbide & Carbon Corp.* v. *Graver Tank & Mfg. Co.*, 196 F. 2d 103, 112, 93 U.S.P.Q. 137 (7th Cir., 1952), that:

> In our opinion, the application of the doctrine of equivalency in this case is to ignore the teachings of the patent, the representation upon which the claims in suit were allowed and, more pointedly perhaps, the representations by which their validity has been sustained in the courts. While the difference between plaintiff's composition and those accused may not be great, it is that difference which distinguished plaintiff's composition from the prior art and which enabled it to sustain the validity of its grant. It is now estopped from claiming otherwise.

Claims 1 and 10 of the Adams patent have been specifically relied upon by the plaintiffs. These two patent claims, set forth in finding 12, each define a combination including a magnesium electropositive electrode and a fused cuprous chloride electronegative electrode. Claim 10 also recites the presence of a carbon catalytic agent in the electronegative electrode. The accused Eagle-Picher and Ray-O-Vac battery units identified in findings 25 and 26 as trial exhibits 7, 8, and 9, each include a magnesium electropositive electrode and a fused cuprous chloride electronegative electrode

as set forth in more detail in finding 34. These batteries infringe claim 1 of the Adams patent. The accused Burgess battery unit identified in findings 28 and 37 as trial exhibit 18 contains a silver chloride electronegative electrode and does not infringe the claims of the Adams patent.

Summarizing, it is found that plaintiffs are the rightful owners of the Adams patent, that the patent is valid, that the invention claimed therein has been used by defendant without license of the owners, that the plaintiffs are entitled to recover compensation for such use, and that the extent of liability should be determined in further proceedings pursuant to Rule 47(c)(2).

Findings of Fact

1. This is a suit involving a patent claim and a contract claim brought under the provisions of 28 U.S.C. §§ 1491 and 1498 and 22 U.S.C. §§ 1668 (repealed) and 1758. The parties [fol. 961] have stipulated that this court has jurisdiction over all of the parties involved and over the issues raised by the petition and answer.

2. The patent claim is for reasonable and entire compensation for unauthorized and infringing use or manufacture by or for defendant, and for the unauthorized and infringing use within the United States in furtherance of the purposes of the Mutual Security Acts of 1951 and 1954 of United States Letters Patent No. 2,322,210 entitled "Battery" which issued June 22, 1943, on an application for patent filed by Bert N. Adams, a plaintiff herein. This patent will be referred to hereinafter as the Adams patent.

3. The breach of contract claim is for reasonable and entire compensation for defendant's breach of an express or implied contract existing between defendant and plaintiffs relating to compensation for use or manufacture by or for defendant of batteries made in accordance with disclosures made to defendant by plaintiff Bert N. Adams.

4. At pretrial conference, the parties stipulated that upon proof of the manufacture by or for, or the use by or for, the defendant, of one or more articles alleged in the petition, or otherwise alleged on the record, to infringe the Adams patent, the issues of patent validity and of infringement of the patent by the defendant would be first deter-

mined upon full proofs, findings of fact, and argument of counsel. The parties further agreed that the accounting issue, including evidence as to the number of articles procured and/or the value of the patented invention, or the extent of the liability, if any, of the defendant, and the amount of reasonable and entire compensation, if any, due to plaintiffs on account thereof, would be deferred until after the entry of the order of the court on the issues of patent validity and/or patent infringement.

5. The ownership of the Adams patent, the application therefor, and the claims against the defendant involved in this suit are as follows:

a. The application for patent was filed December 18, 1941, and from that date through January 14, 1942, ownership of the application and any claims arising during this period was: 10 percent in Olaf Hallingby (owned until July 16, [fol. 962] 1959, by his heirs, Mary Seimers, George Hallingby, Iris Petry, and Jane Maesel), and 90 percent in Bert N. Adams.

b. From January 15, 1942, through January 16, 1942, ownership of the application and the claims arising during this period was: 10 percent in Olaf Hallingby (owned until July 16, 1959, by his heirs, Mary Seimers, George Hallingby, Iris Petry, and Jane Maesel); 45 percent in Bert N. Adams, and 45 percent in Emma Adams.

c. From January 17, 1942, through September 14, 1942, ownership of the application and the patent (which issued on June 22, 1942) and the claims arising during this period was: 10 percent in Olaf Hallingby (owned until July 16, 1959, by his heirs, Mary Seimers, George Hallingby, Iris Petry and Jane Maesel); 45 percent in Emma Adams; 1.35 percent in Ernest Sutcliffe (owned by his heir, Helen Sutcliffe, until July 16, 1959), and 43.65 percent in Bert N. Adams.

d. From September 14, 1942, through April 14, 1959, ownership of the application and the patent and the claims arising during this period was: 10 percent in Olaf Hallingby (owned until July 16, 1959, by his heirs, Mary Seimers, George Hallingby, Iris Petry, and Jane Maesel); 45 percent in Emma Adams; 0.9 percent in Ernest Sutcliffe (owned by his heir, Helen Sutcliffe, until July 16, 1959), and 44.1 percent in Bert N. Adams.

e. From April 15, 1959, through July 15, 1959, ownership of the patent and the claims arising during this period was: 10 percent in Olaf Hallingby (owned until July 16, 1959, by his heirs, Mary Seimers, George Hallingby, Iris Petry, and Jane Maesel); 0.9 percent in Ernest Sutcliffe (owned until July 16, 1959, by his heir, Helen Sutcliffe), and 89.1 percent in Bert N. Adams.

f. From July 16, 1959, through August 30, 1959, ownership of the patent and the claims arising during this period was 100 percent in Bert N. Adams.

g. After August 31, 1959, ownership of the patent (which expired June 21, 1960) and the claims arising during this period was 100 percent in plaintiff Lewis M. Schott.

6. Adams first became interested in batteries in the summer of 1939. While employed at the New York World's Fair, he studied various battery theories at home, and con- [fol. 963] ducted experiments using various types of electrodes and electrolytes in batteries. Finally, Adams discovered that when cuprous chloride was used in combination with magnesium and water, the result was an operable battery.

7. Adams continued experimenting, and in 1940, after accidentally dropping cigarette ashes into the cuprous chloride which he was making into a cathode, he discovered that the addition of carbon improved the battery by increasing the current and providing a substantially level (constant) potential. Subsequent experiments taught Adams that a small addition of magnesium chloride to the electrolyte would increase the speed of activation of the battery and that the addition of a small amount of magnesium sulphate helped to clean the electrodes.

8. On December 18, 1941, Adams filed an application for patent in the United States Patent Office. This application resulted in the issuance of the Adams patent on June 22, 1943.

9. The Adams patent disclosed a battery comprised of a magnesium electropositive electrode (anode), a cuprous chloride electronegative electrode (cathode), and a water electrolyte. The distinctive characteristics of this battery are that it is light in weight, it uses ordinary water as an electrolyte, it may be manufactured and distributed in a dry

condition and may be rendered serviceable by merely filling the container with ordinary water, it may be operated under extremely cold conditions, and, upon complete activation, it produces a linear (constant) potential which continues until the battery is substantially exhausted.

10. The Adams patent contains several illustrative drawings which are reproduced below.

[fol. 964]

June 22, 1943. B. N. ADAMS 2,322,210

BATTERY

Filed Dec. 18, 1941

Fig. 1.

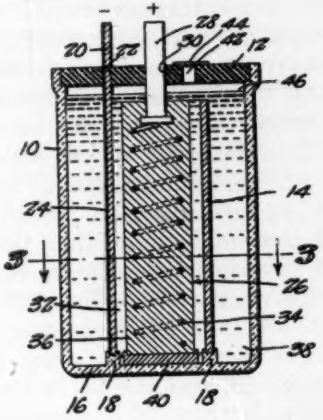


Fig. 2.

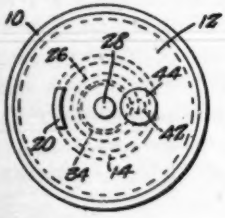
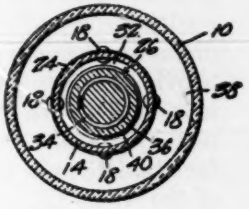


Fig. 3.



[fol. 965] 11. The specification of the Adams patent describes the drawings in part as follows:

> Figure 1 is a sectional view of a battery in accordance with my invention;
>
> Figure 2 is a top plan view; and
>
> Figure 3 is a sectional view taken along the line 3—3 of Figure 1.

In the embodiment selected for illustration, I make use of a container 10 provided with a closure or cover 12 of insulative material. The container 10 may comprise glass or any other material which is waterproof. Inside the container 10 is arranged an electro-positive electrode 14 comprising pure magnesium. The electropositive electrode 14 is in the form of an open ended tube of a length slightly less than the height of the container 10. Projecting upwardly from the bottom 16 of the container are notched ears 18 in which the lower end of the electro-positive electrode 14 is supported. An extension 20 is provided at the upper end of the electropositive electrode 14, which extension projects through an opening 22 in the cover 12 to constitute one terminal of the battery. The outer surface of the electro-positive electrode 14 is provided with a coating of tar 24.

Arranged concentrically within the electro-positive electrode 14 is an electro-negative electrode 26 in the form of a cylinder coextensive in length with the electropositive electrode 14. Embedded in the upper end of the electro-negative electrode 26 is a copper terminal 28 extending through an opening 30 in the cover 12. The electronegative electrode 26 is of uniform diameter less than the inside diameter of the electropositive electrode 14 so as to provide a space 32 for the liquid contained in the battery. To the terminal 28 is connected one end of a copper coil 34 embedded in the core 36. The electropositive electrode 14 is of considerably smaller outside diameter than the inside diameter of the container 10 to provide a space 38 for the liquid, which space has communication with the space 32 at the bottom of the battery by reason of the ears 18 and also by reason of the fact that the electropositive electrode terminates short of the cover 12.

The body 36 of the electronegative electrode 26 comprises fused cuprous chloride (CuCL). In manufacturing the body 36, the coil 34 and the terminal 28 are arranged in a mold and the latter supplied with the requisite amount of cuprous chloride poured from a heated crucible. A piece of wood carbon is placed on the top of the cuprous chloride in the crucible and the [fol. 966] latter is heated to a temperature ranging between 400° and 500° centigrade at which the cuprous chloride may be poured. The wood carbon constitutes a catalytic agent which renders the electronegative electrode 26 successful for the purpose intended, the exact chemical action being unknown to me.

After the electronegative electrode 36 is removed from the crucible, it is cooled and dipped in a 66° Baume solution of sulphuric acid. While still dripping wet, the electrode 26 is covered with aluminium powder to prevent oxidation thereof. The electrode 26 is now ready for use.

The lower end of the electrode 26 is rested on a wood block 40 on the bottom 16. Both terminals 20 and 28 are firmly anchored in the cover 12 so that all the parts are maintained in fixed relationship when assembled with the container.

12. Although all 11 claims of the Adams patent are in suit, plaintiffs have relied specifically on claims 1 and 10. The elements of these two claims are as follows:

Patent Claim 1

A battery comprising

a liquid container,
a magnesium electropositive electrode
inside the container
and having an exterior terminal,
a fused cuprous chloride electronegative electrode,
and a terminal connected with said electronegative
electrode.

Patent Claim 10

In a battery, the combination of

a magnesium electropositive electrode, and
an electronegative electrode comprising cuprous chloride fused with a carbon catalytic agent.

VALIDITY ISSUE

13. Defendant urges that the patent is invalid on the grounds that the invention was fully anticipated by the prior art and is hence invalid under 35 U.S.C. §§ 101 and 102, and that the invention was obvious to those skilled in the art at the time that it was made, and is hence invalid under 35 U.S.C. § 103.

[fol. 967] 14. Defendant has cited 24 prior patents and publications, defendant's exhibits 1-24, identified as follows:

Elementary Treatise on Electric Batteries, Niaudet, 1880, pages ix, 200-209;
Hayes patent 282,634, 1883;
Galvanic Batteries, Bottone, 1902, pages 172-177;
Primary Batteries, Carhart, 1891, pages 62-65;
Barrett patent 405,196, 1889;
Hard patent 457,116, 1891;
Hathaway patent 454,598, 1891;
Van Tenac patent 184,932, 1876;
Fink patent 434,593, 1890;
Pearson patent 512,055, 1894;
Practical Primary Cells, Codd, 1929, pages 1-3, 43, 44, 78-81, 110, 117;
Wood patent 1,696,873, 1928;
Ruben patent 1,920,151, 1933;
Jumau patent 2,078,143, 1937;
Manual of Chemistry, Simon, 1905, page 216;
Essentials of General Chemistry, Hopkins, 1946, pages 371, 372, period table;
Ferrabino British patent 301,923, 1928;
Thurnauer, et al. patent 552,211, 1895;
Skrivanoff British patent 4,341 of 1880;
Wensky British patent 49 of 1891;
Copper-Zinc and Copper-Tin Alloys, Laurie, 1888, pages 104-116;

Parkhurst patent 269, 454, 1882;
Heil patent 653,770, 1900;
Harrison patent 1,522,121, 1925.

15. Nine of these publications disclose batteries utilizing silver chloride; none of these items disclose the use of magnesium. Four of these publications disclose batteries with magnesium as a component; none of these disclose the use of silver or cuprous chloride. Three of these publications disclose the use of cuprous chloride as a single component; none of these disclose its use in conjunction with magnesium. Two of these publications disclose the use of neither magnesium, nor cuprous chloride, nor silver chloride. A total of 18 of defendant's 24 cited publications disclose either none of the components of the Adams system or at most one single component of the system; none of these 18 items disclose the combination of even two of the components. Only three of defendant's anticipatory references disclose more than one component of the Adams system.

[fol. 968] 16. The Codd textbook (on page 22) mentions magnesium but only for use in a cell in which the other electrode is copper and the electrolyte is dilute sulfuric acid. On page 44, in discussing another battery entirely, Codd discusses silver chloride as an electrode. There is no suggestion in Codd that the materials could be combined in a battery.

17. The Skrivanoff foreign patent discloses a battery having an electrode of magnesium, an electrode comprising cuprous chloride *mixed together with* some seven other substances, and a strong electrolyte. The evidence establishes that the disclosure of this very old patent is inoperative.

18. The Niaudet treatise (1880) discloses a battery having an electrode of silver chloride, an electrode of zinc, and plain water as an electrolyte. This disclosure contains no suggestion that magnesium might be substituted for zinc in this battery.

19. The Harrison patent, cited by defendant to show the state of the art, discloses a battery in which the electrodes are immersed in sea water on opposite sides of a ship. One electrode is magnesium and the other is copper. The electrolyte is the sea water. The patent explains that because of exposure to sea water, the potential characteristics and cur-

rent yield for a copper electrode having a given area will gradually improve.

20. The Simon article and the Hopkins article, which were not cited by the defendant as anticipatory references, show that magnesium is an alkaline earth metal. The Juman patent discloses that the electrolyte in a lead chloride-magnesium battery may be a dilute solution of an alkaline earth salt, such as a sulphate or a chloride.

21. Summarizing findings 14 through 20, the cited publications and patents do not anticipate the invention defined in the several claims of the Adams patent.

22. Each of the elements of the several claims of the Adams patent was individually old in the battery-making art at the time of the filing of the Adams application for the patent here in suit. While there is evidence of a definite need for a battery having the characteristics of the Adams battery, those skilled in the art failed to develop one for a period of over 50 years, during which time all of the necessary ingredients were available. There is no evidence that [fol. 969] anyone had ever before suggested the specific *combination* of elements which make up the Adams battery nor that anyone had ever before suggested that such a battery would have a substantially constant potential, could be operated under extreme temperatures, and could be operated with ordinary or distilled water.

23. The Adams invention was the first practical, water-activated, constant potential battery capable of operation at low temperatures. When Adams first disclosed his invention to others skilled in the art, he did not know its theory of operation and it was received with considerable skepticism. However, this development was subsequently recognized throughout the industry as an extremely important step in rounding out the sources of battery-furnished power, and filling important, long-standing needs of both civilian and military natures.

24. Summarizing findings 22 and 23, the Adams invention was not, as a whole, obvious, at the time the invention was made, to a person having ordinary skill in the battery art.

Infringement Issues

25. Plaintiffs contend that batteries embodying the invention and infringing the claims of the Adams patent were used or manufactured by or for defendant without authorization or license of plaintiffs. The parties have stipulated that the batteries identified as trial exhibits 7, 8, and 9 were procured by and delivered to the defendant within the 6-year period preceding the filing of the petition. The parties further stipulated that articles made as described in trial exhibit 1 were procured by and delivered to the defendant within the 6-year period preceding the filing of the petition.

26. Trial exhibit 7 is an Eagle-Picher battery unit designated BA-259/AM. Trial exhibit 8 is a Ray-O-Vac battery unit designated BA-292/AM. Trial exhibit 9 is a Ray-O-Vac battery unit designated BA-253/U.

27. Trial exhibit 1 includes a letter from The Electric Storage Battery Company, stating that they have supplied to the defendant batteries having cuprous chloride plates made in accordance with United States Letters Patent Nos. 2,640,090, 2,640,091, and 2,667,527. These three patents issued on applications filed after the Adams patent issued. [fol. 970] Trial exhibit 1 also includes a letter from Burgess Battery Company stating that the batteries produced by Burgess had a plate made of a paste of cuprous chloride, plastic binder, and graphite. Trial exhibit 1 also includes a letter from The Eagle-Picher Company stating that all the magnesium cuprous chloride batteries which have been produced by Eagle-Picher have been made in accordance with the process outlined in United States Letters Patent No. 2,636,060 and/or Reissue No. 23,883. These two patents issued to the defendant, as represented by the Secretary of the Army, on applications filed after the Adams patent issued. Trial exhibit 1 also includes a letter from Ray-O-Vac Company stating that all of the batteries furnished to the defendant by Ray-O-Vac have had positive plates made in accordance with the process outlined in Patent No. 2,636,060 or Reissue No. 23,883, noted above, by a process involving subjecting a mixture containing cuprous chloride to pressure in a tableting machine to form pellets.

28. Trial exhibit 18, a Burgess battery unit designated X10183, is a water-activated, magnesium and silver chloride

battery introduced by defendant as illustrative of procurement of such devices during the 6-year period next preceding the filing of the petition.

29. Patents Nos. 2,640,090, 2,640,091, and 2,667,527, which are referred to in finding 27, teach a water-activated, magnesium and cuprous chloride battery having a pasted grid type cuprous chloride plate made by mixing cuprous chloride with silver chloride and water, and pasting the mixture on a copper wire screen.

30. Patent No. 2,636,060, referred to in finding 27, teaches a process for making cuprous chloride electrodes for water-activated, magnesium, cuprous chloride batteries. The cuprous chloride electrodes are made by making a pasty mixture of cuprous chloride and water and pasting the mixture on wire screens. Patent Reissue No. 23,883, referred to in finding 27, teaches a process for making cuprous chloride electrodes for water-activated, magnesium, cuprous chloride batteries. The cuprous chloride electrodes are made by making a paste of cuprous chloride, a highly polymeric substance and an organic solvent, and pasting the mixture on wire screens.

[fol. 971] 31. Cuprous chloride is available commercially as a powder. To function as an electrode, the powder must be formed by some means into electrode shape. There are several methods of forming cuprous chloride into electrode shape. One method, which is suggested in the Adams patent, is to place the cuprous chloride in a crucible and heat the crucible until the cuprous chloride is pourable. Then the cuprous chloride is poured into a mold where it is allowed to solidify. This "candlestick" method was known prior to 1880. Another method is to add water to cuprous chloride to form a pourable slurry, which, upon drying, hardens into a unified mass. Still another method is to add toluene to cuprous chloride to form a pourable slurry which, upon drying, hardens into a unified mass.

32. Defendant alleges that by the use of the term *fused* cuprous chloride in the claims the Adams patent is limited to batteries using cuprous chloride electrodes made by the *heat* method. The method of forming the cathode makes no substantial difference in the electrochemical properties of cuprous chloride, whether the method be liquidification by heat, water, or organic material, such as benzene or toluene.

There was considerable testimony at the trial both directly and indirectly relating to the term *fused*. Viewing this testimony as a whole, it appears that the term *fused* is used by some people as meaning unified only by heat. This limitation is by no means universally accepted and other people use the term as meaning unified by any one of a number of methods. One of the definitions given for *fuse* in *Webster's New International Dictionary* (1934 Edition), page 1022, reads: "To unite or blend, as if melted together." The term *fused* as used in the claims of the Adams patent is found to encompass unification or uniting by various methods and is not limited to unification or uniting by heat.

33. Each of Patent Nos. 2,640,090, 2,640,091, 2,667,527, 2,636,060, and Reissue No. 23,883 teaches a unified cuprous chloride electrode which is *fused* within the meaning of the term as used in the Adams patent and claims.

34. Each of trial exhibits 7, 8, and 9 is a pile-type battery. They each have bibulous material which acts as a liquid container, a magnesium electropositive electrode inside the container having an exterior terminal, a fused cuprous chlo- [fol. 972] ride electronegative electrode, and a terminal connected with said electronegative electrode.

35. The evidence is inconclusive and insufficient to determine whether there is carbon in the electronegative electrodes of trial exhibits 7, 8, and 9, as required by the recital of Adams claim 10. However, since each of these exhibits contains each of the elements of claim 1, it is unnecessary to pass upon this question.

36. The cuprous chloride plates manufactured by The Electric Storage Battery Company, Burgess Battery Company, The Eagle-Picher Company, and Ray-O-Vac Company, as described in trial exhibit 1, are *fused* within the meaning of the term as used in the Adams claims.

37. Trial exhibit 18 is a Burgess battery, which includes a liquid container, a magnesium electropositive electrode inside the container having an exterior terminal, a fused silver chloride electronegative electrode, and a terminal connected with said electronegative electrode. It does not have a cuprous chloride electrode.

38. Summarizing finding 25 through 37, claim 1 of the Adams patent has been infringed by trial exhibits 7, 8, and 9. Further, the cuprous chloride plates manufactured by

The Electric Storage Battery Company, Burgess Battery Company, The Eagle-Picher Company, and Ray-O-Vac Company, as described in trial exhibit 1, would infringe claims in the Adams patent if used in a battery otherwise covered by the Adams claims. Trial exhibit 18 does not infringe claims of the Adams patent.

CONTRACT ISSUE

39. The plaintiffs allege that defendant, through its National Inventors Council, made a general offer of a unilateral contract for acceptance by any member of the public by submission of a useful suggestion, with use by the defendant as a condition precedent to liability of defendant. Further the plaintiffs allege that Adams accepted the offer by sending disclosures of his invention to the defendant, and that the condition precedent to defendant's liability has been fulfilled by defendant's use of the invention.

40. It is found that on January 7, 1942, Adams disclosed his invention to the National Inventors Council; that on [fol. 973] January 10, 1942, Adams disclosed his invention to The Chief Signal Officer of the U.S. Army, and that on January 8, 1942, Adams disclosed his invention to the Navy Department. The National Inventors Council replied, asking Adams for more information, which Adams then supplied. Subsequently, Adams informed the National Inventors Council that he was about to receive a patent on the battery, and through the Council he was able to obtain a priority for purchasing magnesium. Both the Signal Corps and the Navy showed immediate interest in the disclosure, and Adams made trips to both Washington, D.C., and Fort Monmouth, New Jersey, where he turned over samples of his battery and made a complete disclosure of his invention to various representatives of the two branches. Subsequently, Adams was in further contact with the personnel at Fort Monmouth and delivered or sent additional information and samples for testing to Fort Monmouth at no expense to the Government. Both the Navy and the Signal Corps finally concluded that the cell offered great promise.

41. The National Inventors Council issued two documents which were available to Adams. The first document was Information Bulletin No. 1–Revised, dated March 1941, and contained, *inter alia*, the following statements:

The submission the the National Inventors Council, under the provisions contained herein, of any description, drawing or other data pertaining to an invention is solely for the purpose of determining its military or naval value. Its acceptance by the Council does not legally obligate the United States Government or act as an estoppel under the patent statutes.

* * * * * * *

The Council has no authority to consider the question of compensation for the use of a suggestion or invention by any Government Department or agency. Should an invention be utilized, the matter of compensation will be referred to the Executive Department of the Government making use of the product embodying the invention. Final settlement for the acquirement of rights can then be arranged between the inventor and the appropriate official of the Department making the purchase.

The amount of compensation can be considered only after tender of the suggestion or invention, and its adoption by an executive branch of the Government. [fol. 974] The creation of the Council does not in any way affect the existing laws or practices of the Government Departments as to compensation.

The second document was Information Bulletin No. 2—Revised 1942, and contained, *inter alia*, the following statement:

* * * In such event, the appropriate departments of the Army and Navy then deal directly with the inventor in making the necessary arrangements for the use of the invention. The Council itself does not consider the question of compensation or contracts between inventors and the Army or Navy. The negotiation of such contracts is conducted by the appropriate Military and Naval authorities.

Conclusion of Law

Upon the foregoing findings of fact, which are made a part of the judgment herein, the court concludes as a matter of law that United States Letters Patent 2,322,-210 is valid; that the invention covered by said patent was used by defendant without authorization of the patent owners, and that plaintiffs are entitled to recover reasonable and entire compensation for such unauthorized use, and judgment will be entered to that effect. The extent of liability will be determined in further proceedings before a trial commissioner, pursuant to Rule 47 (c) (2).

[fol. 975] [File endorsement omitted]

IN THE UNITED STATES COURT OF CLAIMS

No. 163-60

BERT N. ADAMS, et al., Plaintiffs,

v.

THE UNITED STATES, Defendant

MOTION TO ALTER OR AMEND THE OPINION AND JUDGMENT OF THE COURT OF APRIL 17, 1964, OR FOR A REHEARING—Filed May 11, 1964.

Plaintiffs respectfully move this Court, pursuant to Rule 68, to determine the issue of the breach of the alleged implied contract* and to provide for a determination of the amount of recovery under said contract claim by the trial commissioner, pursuant to Rule 47 (c) (2), and to alter or amend its opinion and judgment dated April 17, 1964 accordingly. A rehearing is prayed should the Court deem that the same would be helpful.

* * * * * * *

[fol. 976] Respectfully submitted, John A. Reilly, Attorney for Plaintiffs, 165 Broadway, New York 6, New York.

[fol. 977] Of Counsel: Theodore S. Kenyon, Esq., Charles R. Brainard, Esq., William J. Ungvarsky, Esq., Kenyon & Kenyon, 165 Broadway, New York 6, New York.

May 7, 1964.

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* "Contract" as used herein is intended to include plaintiffs' allegations of express and implied contract and an unlawful taking under Article 5 of the Constitution.

[fol. 978] IN THE UNITED STATES COURT OF CLAIMS

No. 163-60

BERT N. ADAMS, EMMA ADAMS, GEORGE HALLINGBY (Individually and as executor of the estate of Olaf Hallingby, Deceased), JANE MAESEL, IRIS PETRY, LEWIS M. SCHOTT, MARY ELLEN HALLINGBY SEIMERS, and HELEN LOUISE SUTCLIFFE (individually and as Executrix of the Estate of Ernest M. Sutcliffe, Deceased)

v.

THE UNITED STATES

John A. Reilly for plaintiffs. *Richard A. Huettner, William J. Ungvarsky* and *Kenyon & Kenyon* were on the brief.

Paul F. Arseneau, with whom was *Assistant Attorney General John W. Douglas,* for defendant.

Before JONES, *Senior Judge,* WHITAKER, *Senior Judge,* LARAMORE, DURFEE, and DAVIS, *Judges.*

OPINION ON PLAINTIFFS' MOTION TO ALTER OR AMEND THE OPINION AND JUDGMENT OF THE COURT OR FOR A REHEARING, PLAINTIFFS' MOTION FOR LEAVE TO FILE SUPPLEMENTAL PETITION, AND DEFENDANT'S MOTION FOR AN ORDER COMPELLING CLARIFICATION OF PLAINTIFFS' INCONSISTENT REPRESENTATIONS—(Decided October 16, 1964)

PER CURIAM: We have carefully examined plaintiffs' motion to alter or amend the opinion and judgment of the court, dated April 17, 1964, —— Ct. Cl. ——, 330 F. 2d 622, or for a rehearing. We have also reconsidered Findings 39–41 of our Findings of Fact. The facts in this case do not [fol. 979] establish the existence of a contract, express or implied, between defendant and plaintiffs. *Gearon* v. *United States,* 136 Ct. Cl. 548, 115 F. Supp. 910 (1953); *Fulmer* v. *United States,* 144 Ct. Cl. 812 (1859).

Plaintiffs' motion to alter or amend the opinion and judgment of the court or for a rehearing and defendant's motion for an order compelling clarification of plaintiffs' incon-

sistent representations are denied. Plaintiffs' motion for leave to file supplemental petition is granted as to the claim of patent infringement (by use of cuprous chloride electrodes) from May 2, 1960, to June 22, 1960, with leave to defendant to assert special defenses peculiar to the added period and not already considered by the court. The question of the extent of liability, and the question of liability for the period covered by the supplemental petition, will be determined in further proceedings before a trial commissioner pursuant to Rule 47 (c) (2).

[fol. 980] SUPREME COURT OF THE UNITED STATES

No.

OCTOBER TERM, 1964

UNITED STATES, Petitioner,

v.

BERT N. ADAMS, et al.

ORDER EXTENDING TIME TO FILE PETITION FOR WRIT OF CERTIORARI—January 21, 1965

Upon Consideration of the application of counsel for petitioner(s),

It is Ordered that the time for filing a petition for writ of certiorari in the above-entitled cause be, and the same is hereby, extended to and including February 13th, 1965.

Earl Harrey, Chief Justice of the United States.

Dated this 21st day of January, 1965.

[fol. 981] SUPREME COURT OF THE UNITED STATES

No. 906

OCTOBER TERM, 1964

UNITED STATES, Petitioner,

v.

BERT N. ADAMS, et al.

ORDER ALLOWING CERTIORARI—March 29, 1965

The petition herein for a writ of certiorari to the United States Court of Claims is granted, and the case is placed on the summary calendar. The case is set for oral arguments immediately following Nos. 778 and 810.

And it is further ordered that the duly certified copy of the transcript of the proceedings below which accompanied the petition shall be treated as though filed in response to such writ.

☆ U. S. GOVERNMENT PRINTING OFFICE: 1965 780831